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ASTRONOMY.

PERSONAL OBSERVATIONS OF THE ECLIPSE.

BY EDWIN R. WEEKS.

EDITOR OF THE WESTERN REVIEW:

In compliance with your request I inclose a few hurried remarks on the recent solar eclipse as seen from Denver. A few general remarks in regard to the phenomena of solar eclipses may not be out of place. Solar eclipses are either *partial*, *annular* or *total*, and by virtue of the inclination of the orbit of the moon to that of the earth, can occur only when the *new* moon is at or near one of her *nodes*. When the moon's position is such that only a part of the sun's disc is hidden from view, the eclipse is partial; when the moon is at or *very* near one of her nodes, and her disc is not large enough to cover that of the sun, leaving a ring of his disc visible around her dark body, the eclipse is annular; when the moon is at or quite near one of her nodes and presents a disc equal to or larger than that of the sun, the eclipse is total. These last conditions were fulfilled in the eclipse of to-day. The change in the apparent relative diameters of the two bodies is due to the elliptical form of the orbits of the moon and earth.

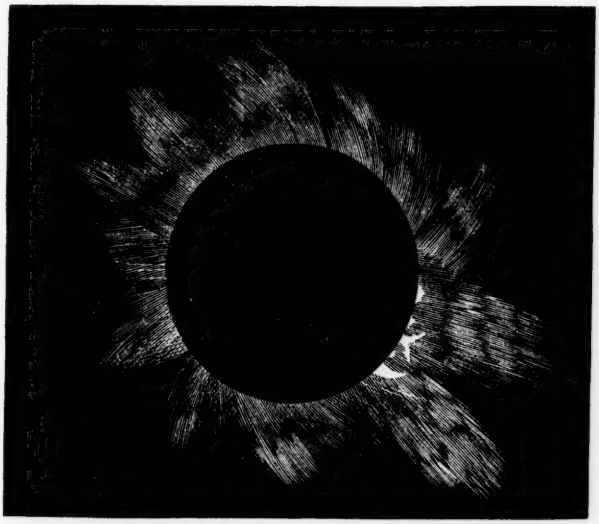
A total eclipse derives its importance from the opportunity it affords for testing the accuracy of the lunar tables, from its being the only time when the solar appendages can be subjected to investigation, and also from its being the only time when the intra-Mercurial space can be searched for the mythical (?) Vulcan.

For several weeks prior to to-day there had not been a day suitable for observation at this place. Many mornings dawned beautifully clear, but towards noon, with provoking regularity, billows of cumulous clouds rolled down from the mountains and hovered over our fair city like birds of ill omen, reducing to zero the hopes of astronomers, rousing the ire of many of our citizens and exciting the anxieties of all. But, despite the unpromising days preceding, to-day has proved all that could be desired, being absolutely free from clouds up to one o'clock p. m., and substantially so throughout the entire day. The only clouds to be seen were a few light ones of the cirrus and cumulous orders that hung nearly stationary about the snowy range, causing little if any uneasiness. During the afternoon a cool breeze blew steadily from the southeast with just enough force to refresh without interfering with careful observation.

The eclipse has been the almost exclusive theme of conversation in Colorado for many days. The masses at last seem to be gaining an inkling of the true import of such an event, for cheering interest was manifested on every hand by intelligent remarks, enthusiastic preparation for observation and sincere wishes for success. It seems that intelligent interest in phenomena of this class is surely becoming more general—a fact full of encouragement for our astronomers.

In seasonable time, armed with a refractor three inches in aperture and accompanied by an assistant, we repaired to "Capitol Hill" to join the party of Prof. W. E. Lyford (Professor of Physics in Colby University). Putting everything in readiness we waited expectantly for the eclipse to begin. The Signal Service telegraphed that the time of *first contact* would be 2:16, Denver time. Some one fond of a joke posted a notice in the post office (purporting to be the latest "official" from the Signal Service) to the effect that the moon had been delayed three hours by a "washout on one of the railroads. Although not detained by a "washout," the moon certainly was about three and one-half minutes behind the Signal Service time, during which delay we strained our eyes most painfully, watching to note the second of first contact, which did not occur until 2:19.31, p. m., Denver time. Profs. Lyford and Colbert (of the Colby and Chicago Universities, respectively) each computed the time of commencement and agreed in making it 2:19.20, a much nearer approximation; in fact, within 11 seconds of the actual observed time. After noting the time and point of first contact, we concluded to prepare our eyes for effective work during the all-important *totality*, by resting and looking about us. To the south was the Princeton party under Prof. Young; to the west the Chicago party in charge of Profs. Colbert, Hough and Swift; to the north and northwest were several parties, the more noted of whom were the party sent out by the Chicago *Times*, under Prof. Burnham; the party from Woodstock University, under Father Sistini; and the Vassar party, in charge of Miss Maria Mitchell. As the light diminished, objects, from persons standing near, to the city with its roofs covered by observers, and beyond to the deceptive foot-hills and fickle mountains, everything, appeared gloomy, weird and unnatural. As the time of totality drew near all eyes were turned in the direction of Long's Peak to note the approach of the eclipse shadow. The mountain was al-

most hidden from view by a number of light, silvery clouds, that, as the shadow approached, were instantly transformed to a delicate purple. Warned by this beautiful token, all made instant preparation to observe the phenomena of totality.



Sketch of Corona and Protuberances as they appeared during the latter part of totality. The prominences are exaggerated in order to more clearly show their peculiar shapes.

The time of *second internal contact* (beginning of totality) was 3:29.4. At the instant of contact the Corona flashed into view. Its light was of the purest, silvery white, unsullied by any other tint, and faded gradually from the greatest brightness at its base to the faintest silvery thread, barely perceptible on the deep violet back-ground of the sky. Its light seemed constant; could detect no fluctuation whatever. Its general structure was radial, not nebulous. Individual rays could be traced throughout their entire length. In the direction of the ecliptic the rays were mostly straight and coincident with the sun's radii prolonged, although some curved quite notably, intersecting others at various angles. But by far the more interesting and peculiar features were the distinctly spiral polar extensions, remarkable for their length and decided curvature. This was especially true of the rays springing from the upper limb, some of which, at first glance, seemed almost tangential, but a careful observation revealed the fact that the greatest angle formed by any with prolongations of the sun's radii at their bases could not exceed 30° or 35°, which, of course, would form very respectable secants.

The greatest extent of the corona was from the western limb in the direction of the ecliptic, and was a trifle more than a semi-diameter of the sun. From the eastern limb the extent was not so great, while from the upper and lower limbs it was least, being rather greater than the sun's semi-radius. Owing to the grad-

ual diffusion of its light it was impossible to determine the exact extent of this beautiful, flashing appendage, the delicate, subtile nature of which may possibly be more fully understood when we observe that we saw Delta-Cancri, a star of the fourth magnitude, shining through its substance. However, we estimated its greatest height at rather more than 500,000 miles. The beautiful phenomenon known as "Bailey's Beads," was observed for three or four seconds at the beginning and end of totality. These delicate objects appeared as somewhat irregular globules of light, intensely brilliant, tending, by their general appearance and duration, to strengthen the popular theory that they are caused by the lunar mountains dividing into fragments the slender threads of the *chromosphere* visible at the beginning and end of totality. A few seconds before the close of totality, the beautiful ruddy layer of glowing hydrogen called the chromosphere sprang into view, extending along the western limb about 120°, and remaining visible about six seconds, when it was shivered into as many as 35 or 40 fragments (Bailey's Beads), altogether forming one of the most beautiful and never-to-be forgotten sights ever witnessed by the writer.

The well-known solar protuberances were neither so numerous or prominent as on former occasions, only five being seen, protruding from that part of the sun's western limb near the point of first contact. Two of these were quite prominent and clearly defined, the others were small. The first in size was broadest at its base and tapered to a fine point at its extremity, which was strongly curved to the north, giving it a shape much like that of a horn. We estimated its height at fully 45,000 miles. The second, from a more narrow base, spread to a point where it divided into two forks, which, with their minor offshoots, presented a decidedly unique figure, somewhat resembling the antlers of a deer. These prominences seemed perfectly quiescent. As the dark body of the moon passed on, revealing successive parts of the largest one to view, its color was seen to range from the purest white at its extremity to a delicate pink in the center, merging into a rich rose color at the base.

Our search for Vulcan proved unsuccessful. The darkness was not so great as we expected, although chickens sought their roosts and Mars, Venus, Mercury and several of the brighter stars were conspicuous objects to the naked eye.

As totality closed we glanced regretfully after the dusky shadow, gliding swiftly away to greet the eager eyes of other observers posted along its path. The time of the *third internal contact* (end of totality) was 3:31.45. The temperature fell perceptibly during totality but quickly recovered, reaching its *maximum for the day at 5:10 p. m.* The *fourth external contact* (end of the eclipse) took place at 4:35 p. m.

Many attribute the remarkable fitness of to-day to the proverbial devotion of astronomers, for has not the assertion of the poet Young that "an undevout astronomer is mad," passed into a proverb? With all possible respect for Young, and a firm belief in the strong tendency of astronomical research to develop veneration for the Creator, the Great First Cause, the "Eternal One, whose presence bright all space doth occupy, all motion guide," we still venture the opinion that if

to-day had proved cloudy, this evening's prayers of the scores of astronomers in Colorado, if not entirely neglected, at least would not be offered in "spirit and in truth." We are confident that the members of our party would feel very wicked. But, as it is, the feeling of gratitude is general, and belief in special Providence is greatly strengthened.

Denver, Colorado, July 29th, 1878.

THE SOLAR ECLIPSE OF JULY 29, 1878.

PREPARED BY THE EDITOR.

It seems quite certain that the eclipse of July 29th was not as fruitful of important results to the scores of learned and skilled astronomers from the observatories of Europe and America, who were present at various points along the line of its totality, as was expected; nevertheless, many valuable observations of the corona, protuberances, intra-Mercurial planets, and other objects of scientific interest were made which will in due time be given to the public.

In the mean time we herewith give a condensed statement made up from the verbal reports of eye witnesses and from the special telegrams sent to the daily papers of St. Louis, Chicago and this city.

An appropriation of $8,000 having been made by Congress for the purpose of aiding the official observation of this eclipse, Admiral Rogers, Superintendent of the U. S. Naval Observatory, sent out five parties from various colleges and observatories, under command of professors of Mathematics in the navy and officers of the line.

The following is a complete list of the parties sent out or assisted by the observatory, their instructions and their proximate points of observation: Prof. S. Newcomb, Commander W. T. Sampson, Lieut. C. G. Bowman and John Meier were located at Creston, Wyoming, with instructions to photograph with one of the photo-heliographs used in photographing the transit of Venus in December, 1874. Also to observe contacts and look for intra-Mercurial planets. The following party was stationed at Pueblo, Colorado: Prof. A. Hall, Prof. J. A. Rogers, Prof. A. W. Wright, Mr. H. F. Gardner and Mr A. B. Wheeler, to take photographs of the eclipse, corona, and all around it that could be gotten on a plate; make polariscopic observations of the light of the corona; observe time of contacts, and make a search for intra-Mercurial planets. The next party was located at Creston, Wyoming, and was made up as follows: Prof. Wm. Harkness, Lieut. E. W. Sturdy, Assistant Astronomer A. M. Skinner, Messrs. L. E. Walker, A. G. Clark and Prof. O. H. Robinson. This party had the same instructions as Prof. Hall's, except that instead of polariscopic observations they were to take spectroscopic and thermo-electric observations. At Pueblo, Colorado, there were stationed Prof. J. R. Eastman, Prof. Lewis Ross, Assistant Astronomer H. M. Paul, and Mr. H. S. Pritchett, son of Prof. Pritchett of Glasgow, Mo. This party was directed to take polariscopic observations, observe

contacts, search for planets, and make drawings of the corona. The following party was stationed at Central City, Colorado: Prof. E S. Holden, Lieut. T. W. Very, and Dr. C. S. Hastings. They were assigned to the mountains southwest of Denver, to search for planets, and investigate structure of corona.

Mr. L. Trouvelot, of Cambridge, Mass., a most skillful artist, accompanied by his son, was sent to Rawlings, Wyoming, to make a drawing of the corona; Prof. Edison was also at Rawlings. Mr. G. W. Hill, of the Nautical Almanac office, was stationed on one of the mountains in Colorado to make drawings of the corona. Prof. Ormond Stone, of Cincinnati, and Mr. Winslow Upton, of Cambridge, observed the eclipse from the lofty peaks of Colorado, at Schuyler. Gen. Myers and Prof. Abbe, of the Signal Office, and Prof. Langley, of Pittsburg, were stationed on the summit of Pike's Peak. They were obliged to take their instruments apart and carry them by hand to an elevation exceeding 14,000 feet. Mr. D. P. Todd, went to Texas and made arrangements for observing duration of totality near the limits of total eclipse at Dallas and other places. Many distinguished English astronomers and M. Jansen, the famous astronomer from Paris, were also at hand to observe the eclipse.

Profs. C. A. Young, C. F. Brackett, and C. S. Rockwood, of Princeton, N. J., with Messrs. W. Libbey, Jr., G. H. Calley, C. D. Bennett, W. McDonald C. J. Young, and H. S. S. Smith were near Denver, chiefly working with the spectroscope. Maria Mitchell, of Vassar, was also near Denver. Norman Lockyer, Dr. Schuster, Prof. J. C. Watson, of the Detroit Observatory, and Prof. Thorpe, of England, were in the same neighborhood, with the telespectroscope, and the last named gentleman made a series of meteorological observations at several points. The Chicago Astronomical Society was represented at or near Denver by three of its members, Prof. G. W. Hough, S. W. Burnham, and Prof. E. Colbert.

As will be seen, the utmost care was taken to select the most favorable points from which the observations could be made unaffected by bad weather or other terrestrial or atmospheric hindrances. Every facility for thorough observation was provided, and the work so divided up among the individual members of each party as to secure from each his undivided attention to the observation of particular features of the great phenomenon, thus securing the fullness and accuracy of detail so important in a scientific point of view. This was the first total solar eclipse that has been visible in this country since that of 1869, which received the attention of our astronomers and was fully observed. The eclipse of 1878 may be regarded as a return, or rather as a completion of the cycle of the eclipse of July 18, 1860. The dark shadow of the moon first struck the earth in Siberia and crossing Behrings Straits, the line of totality—which covered a space of about 116 miles wide—entered the United States at the northwest corner of Montana Territory, and moving in a southeast direction, swept over the Yellowstone Park, through Wyoming Territory, Denver, Colorado, Northern and Eastern Texas, and entering the Gulf of Mexico, between New Orleans and Galveston, crossed the islands of Cuba and San Domingo, and then left the earth. As the line of totality remained so long in this country, there was abundant time to observe all the many

curious and important phenomena connected with it. Much interest was attached to the eclipse by scientists, who looked upon it as the means of determining many vexed questions. First, and perhaps the most important, as it is of practical value to the navigator, were the corrections to be obtained to the present solar and lunar tables. Notwithstanding the remarkable accuracy already obtained, the location of the central line of the eclipse, as calculated by the American Nautical Almanac, differs by about four miles from that derived from the English Nautical Almanac. Important observations were also to be made respecting the physical constitution of the sun. The polariscope and the spectroscope were used to examine the corona of the sun during totality. As the duration of totality was not more than three minutes in the North, and two and a half in Texas, all the observers were required to work very rapidly in order to obtain the desired observations.

Advantage was taken of the sun's obscuration by the dark moon to examine the heavens in the neighborhood of the sun for Vulcan and one or more other small bodies that might be added to our solar universe. Besides this careful telescopic scrutiny, large photographs were taken of the heavens, in order to allow the small planets, if any there be, to print themselves upon the photographic plate, and thus announce to the world the fact of their existence and their influence upon the motions of their neighbor, Mercury.

The results of all these observations were reported to the *Chicago Tribune*, by Prof. Colbert, of the Chicago University, as follows:

The Chicago Astronomical Society observed from Capitol Hill, in Denver, commanding a magnificent view of the mountains to the northwest.

The first contact was at 2h. 19m. 30½s., local time. The second at 3h. 28m. 3½s. The duration of the totality was 2m. 40½s., being 3½s. less than the computed time. The last contact was at 4h. 35m., which shows that the moon's path was further south than calculated, or her diameter was estimated too large. We looked vainly for Vulcan, but there was too much light to see a small object so far away.

Prof. Thomas saw the line numbered 1,474, in the spectrum of the corona, but no new lines. The corona was much smaller than usual and measured an average of 26 minutes of arc from the moon, or 700,000 miles high. It was very pale, almost white. The corona was strongly striped in spiral rays thirty degrees from the direction of the radius. It flared most markedly in the direction of the ecliptic. Prof. Hough saw the chromosphere, extending some 3,000 miles from the sun's normal surface. There were very few protuberances and they were very pale. Two on the western side of the sun were the largest.

The scarcity of the red flames tends to confirm the theory of connection with the sun spots. This is near the minimum of the spots.

A class of about twenty citizens made drawings in this section, which will be compared and averaged at the Dearborn Observatory. Hawkins, of Denver, took several instantaneous pictures with the camera, which develop well and are very valuable.

Mr. Penrose, of London, England, was at Denver. He observed the landscape while the shadow was sweeping over it. He makes the time of totality two minutes forty-six seconds, but this probably included the duration of Bailey's beads, two and a half seconds, before totality, and the light, one and one-half seconds after, as seen by a Chicago Society party. Sergt. Barwick, of the Denver Signal Service, observed the sun. The thermometer fell from 114 to 82 during totality.

At Central City the observations were a decided success. The duration of totality was two minutes and fifty seconds. Prof. Young's party was fairly successful in observing the corona, and looking for Vulcan without finding him. They discovered no new lines in either the ultra red or the ultra violet. At the moment of totality all the Fraunhofer lines were seen brilliantly reversed, bursting out like rockets. Lines were seen near B, confirming Pogson's observations. They did not reduce the times of contact. One student saw a continuous spectrum with the interating spectroscope, and the line 1,474 was seen at the beginning and end of totality, but faded in the middle of the phase.

Mr. Raynard, of England, with Young, took two good photographs, but his driving clock got out of order.

Maria Mitchell's party saw the corona much more brilliant than in 1869, but the rosy flames were poorly marked. Saw Venus, Mars, Mercury and four stars, but no Vulcan. They made an oil painting of the corona.

Father Sistini, with a party from Maryland, saw the corona extend one and a half times the moon's diameter, and elsewhere half the same, making it the greatest measure seen.

Stone, of Cincinnati, near Denver, observed the contacts and measured the cusps.

The duration at Kit Carson was three seconds. It was not quite total at Greeley.

Prof. Louder, of England, saw at Denver, about one minute after totality began, a bright object like a star at a distance of twenty minutes of arc from the sun, and forty degrees from the north toward the east. It was visible till the total phase ended.

Swift, of Rochester, with the Chicago party, saw directly east of the sun two reddish stars, about three degrees from the sun and two minutes apart.

Do these observations show the existence of Vulcan? After all, Young and some other astronomers are more grounded in the belief that there is no Vulcan. This is the first time in eclipse history of stars seen and not known, and yet some doubt it is certain that the perturbations of Mercury can be accounted for by reference to cosmic matter which is inside the orbit of Mercury only at perihelion, and Prof. Hill, of Washington, has detected perturbations of the earth and Venus which accord with this view.

Profs. Eaton and White, of Brooklyn, located at Idaho Springs, report seeing Bailey's Beads, but no red prominences. The duration of totality was two minutes, forty-eight seconds.

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From Denver, Col., Prof. Sistini reports: Toward the end of totality, observed some small continuous protuberances. There were streaks of light and shade on the ground preceding totality, a bright corona around the whole solar disc, with luminous offstarts on both sides in the direction of the motion of the moon, each extending about one diameter and a half of the sun, also two more offstarts nearly at right angles to the former, about half the solar diameter in length. The Vassar party report unimportant observations. They saw three planets and four stars. The Princeton party, the best supplied with improved appliances, made a special study of the structure of the corona and protuberances. Prof. Young reports very satisfactory results, but the discovery of nothing not before known to science. The corona was unusually faint and remarkable for its polar extension. No new bright spectral lines were visible in the ultra red or violet. All the Fraunhofer lines were beautifully represented in most instruments, the two H. H. strangely reversed. This is considered by astronomers quite remarkable. A good photograph was obtained of the corona. No new planets were discovered. Prof. Young expressed himself more than satisfied with the results of his observations. Prof. Louder reports, about one minute after totality began, a bright object like a star or planet was seen at a distance of 20 minutes from the sun's limit; position as seen in inverting telescope, 40 degrees to the right from the bottom of the field of view. It remained visible in the telescope till the end of totality. No known star or planet has ever been seen in this position.

Prof. Colbert's observations on the corona did not disclose any specially new features beyond the noting of the peculiar spiral character of coronal rays. Totality lasted 2 min, 40½ sec.; Bailey's Beads noticed 2½ seconds at the beginning of totality, and 1½ seconds at the end. Prof. Hough reports the entire phenomena presented entirely different in appearance to the eclipse of 1869, and to European eclipses of 1870 and 1875. Measurement of corona, 26 minutes, indicating diameter of solar atmosphere about 700,000 miles. Prof. Swift reports careful search for Vulcan without success. He saw, three degrees from the sun, two stars not down on the charts or star maps, and about as bright as the pole star, pointing directly toward the sun. A brilliant corruscation of light was seen on the moon's disc opposite protuberances.

Reports from twenty-five observing parties agree in the main particulars. No party has yet reported seeing the new planet observed by Prof. Louder. The spectacle was magnificent, and no doubt the observations taken, upon the whole will add largely to the world's fund of scientific knowledge.

The time of first contact was 2:20, Denver time, and ten minutes later the presence of the moon at the edge of the sun's disc was plainly perceptible to ordinary observers with smoked glass. By three o'clock the sunlight had moderated in a marked degree, showing a pale yellow color. Later on a lurid glare overspread the earth, the heat of the sun was no longer oppressive, and a light similar to twilight was shown in the horizon, and the light flecks of clouds began slowly to dissolve, owing to a change in the temperature. As the period of totality came on the sight from an elevated station was grand. An extreme dark

shadow fell on Long's Peak, seventy five miles distant, and sweeping rapidly southeastward, covered the plain like a gray pall. To the northeastward clouds could be seen bathed in sunlight, and presenting the view of a beautiful sunset. During the period of obscuration the moon appeared like a huge black ball.

At Rawlins, Wy., the weather was fine, the sky clear and the observations a perfect success. Dr. Draper, of New York, succeeded in obtaining several photographs of the sun during the eclipse. Prof. Watson of Ann Arbor, and Mr. Norman Lockyer returned early from Separation, where the total eclipse lasted two minutes and fifty seconds. Prof. Watson discovered an intra-Mercurial planet of the size of a four and a half magnitude star about two and a half degrees southwest of the sun. Mr. Lockyer says this eclipse was totally different from the one in 1871, the corona being ten times brighter this time, showing a great variation of the brightness of the corona between the maximum and minimum period of sun spots. He obtained a faint photograph of the continuous spectrum of the sun, and it showed no trace of lines of rings through Mr. Rutherford's grating. The structure of the corona was well observed by him, but no trace of an exterior ring was seen, and the corona vanished instantly, while in 1871 it remained for several minutes after totality. Only one faint protruberance was observed by Mr. Lockyer. He is greatly surprised at the difference of eclipses occurring in different sun spot periods, and at the intimate relation of the brightness of the corona to sun spots.

At Dallas, Texas, observations of the solar eclipse were generally successful. The clouds interfered somewhat with all observations until near the time of the last contact. The following observations are furnished by Prof. D. P. Todd, of Washington: First external contact at 4 hours 33 minutes 6.5 seconds; second internal contact, 5 hours 38 minutes 33.3 seconds; third internal contact, 5 hours 40 minutes, 57.9 seconds; fourth external contact, 6 hours 40 minutes 25.6 seconds. The record is in Washington mean time. Professor Todd made a careful search for the supposed intra-Mercurial planet with a four inch telescope—none was seen. The clouds were so dense that no objects whatever were seen near the sun. The corona was very brilliant. Several drawings were secured and photographs taken. Prof. Todd was well satisfied with the results of his observations.

At Fort Worth, Tex., for several days beforehand a party of astronomers was located taking preliminary observations for the great eclipse. The party consisted of Leonard Waldo, of Cambridge observatory, general director of the expedition and specially in charge of its photographic work: R. W. Wilson, of Harvard, who noted times of contact and made extensive physical observations: Prof. John K. Rees, of Washington University, St. Louis; W. H. Pulsifer, of St. Louis, and F. E. Seegrave, of Providence R. I., whose labors were in the main directed to the doubtful points, as the corona and its spectrum. The party were magnificently fitted out with telescopes, spectroscopic and polariscopic apparatus, and had with them a skillful photographer from Dallas. Time observations were taken with great care, and every thing got in readiness for the day's work. Day broke

threatening and cloudy, but cleared up at 3 o'clock and stayed clear till all was over. All four contacts were successfully observed. The first contact occurred at eleven mimutes after 3 and the last contact at nineteen minutes after 5, local mean time. The duration of totality was 2 minutes and 30 seconds. The corona was seen in its lower layers entirely surrounding the sun and extending in two great flashes or tufts of auroral light from the east and west limbs. Wilson observed three large prominences, not pink or red, but of a mother-of-pearl tint, and of vast magnitude. The contacts were observed with the spectroscope, and seen sharply at that. Mr. Pulsifer witnessed the reversal of the Fraunhofer lines, and Seegrave saw line 1,474 and measured its thickness. Five photographs of unmistakable excellence were secured, and it is believed those taken with the polariscope will settle some important points as to the constitution of the corona. The spectroscopic observations confirmed those of Young and Harkness as to the continuous spectrum of the corona. Observations as to limit of shadow and duration of totality were taken by assistant observers at McKinney, Dallas and Bresmond. The whole expedition is considered an entire success in point of observations, pictures and sketches.

We are indebted to Prof. Lewis Swift, of Rochester, New York, one of the most distinguished astronomers in the country, who was with the Chicago *Tribune* party to visit the line of totality in the eclipse of Monday, for the following personal information in regard to that most remarkable phenomenon: The eclipse in many respects was not equal to that of 1869, owing to the fact that there was almost a total absence of protuberances. But as far as the corona was concerned it surpassed all modern eclipses. Some idea may be formed of the immense length of the coronal streamers, when told that the sun's diameter is equal to 850,000 miles and the length of the pencils of light that go to form the corona must, if they extend that distance, be each equal in length to 850,000 miles. The party sent out to Denver by the Chicago *Tribune*, consisting of Profs. Colbert, Hough and Swift, of Rochester, N. Y,, inaugurated a class whose special duty it was to draw the corona as it appeared to the naked eye. Over one dozen were drawn, and some drew them to the unheard-of length of over three times the sun's diameter, or equal to 2,550,000 miles. Prof. Watson claims to have discovered Vulcan, and Prof. Swift also saw the same object, but he makes the distance (by estimation) one half a degree greater and its brightness half a magnitude less. There can be but little doubt but that this hypothetical world has at length been found, thanks to the total eclipse and the zeal of our American astronomers. Two protuberances were seen, and those only near the end of totality. They were of the usual pink color, but very unique in shape, one resembling a hook, which must have projected 50,000 miles from the sun, and the other resembled the antlers of a deer. Bailey's Beads were distinctly seen and also the chromosphere, at that part of the sun which the moon uncovered three or four seconds before the end of totality. It is a layer of red-hot hydrogen, some two thousand miles in thickness, extending over the entire surface of the sun. It is from this layer that the protuberances are formed, which the spectroscope decides to be incandescent hydrogen.

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At Rawlins, Wy., the weather was fine, the sky clear and the observations a perfect success. Dr. Draper, of New York, succeeded in obtaining several photographs of the sun during the eclipse. Prof. Watson of Ann Arbor, and Mr. Norman Lockyer returned early from Separation, where the total eclipse lasted two minutes and fifty seconds. Prof. Watson discovered an intra-Mercurial planet of the size of a four and a half magnitude star about two and a half degrees southwest of the sun. Mr. Lockyer says this eclipse was totally different from the one in 1871, the corona being ten times brighter this time, showing a great variation of the brightness of the corona between the maximum and minimum period of sun spots. He obtained a faint photograph of the continuous spectrum of the sun, and it showed no trace of lines of rings through Mr. Rutherford's grating. The structure of the corona was well observed by him, but no trace of an exterior ring was seen, and the corona vanished instantly, while in 1871 it remained for several minutes after totality. Only one faint protruberance was observed by Mr. Lockyer. He is greatly surprised at the difference of eclipses occurring in different sun spot periods, and at the intimate relation of the brightness of the corona to sun spots.

At Dallas, Texas, observations of the solar eclipse were generally successful. The clouds interfered somewhat with all observations until near the time of the last contact. The following observations are furnished by Prof. D. P. Todd, of Washington: First external contact at 4 hours 33 minutes 6.5 seconds; second internal contact, 5 hours 38 minutes 33.3 seconds; third internal contact, 5 hours 40 minutes, 57.9 seconds; fourth external contact, 6 hours 40 minutes 25.6 seconds. The record is in Washington mean time. Professor Todd made a careful search for the supposed intra-Mercurial planet with a four inch telescope—none was seen. The clouds were so dense that no objects whatever were seen near the sun. The corona was very brilliant. Several drawings were secured and photographs taken. Prof. Todd was well satisfied with the results of his observations.

At Fort Worth, Tex., for several days beforehand a party of astronomers was located taking preliminary observations for the great eclipse. The party consisted of Leonard Waldo, of Cambridge observatory, general director of the expedition and specially in charge of its photographic work: R. W. Wilson, of Harvard, who noted times of contact and made extensive physical observations: Prof. John K. Rees, of Washington University, St. Louis; W. H. Pulsifer, of St. Louis, and F. E. Seegrave, of Providence R. I., whose labors were in the main directed to the doubtful points, as the corona and its spectrum. The party were magnificently fitted out with telescopes, spectroscopic and polariscopic apparatus, and had with them a skillful photographer from Dallas. Time observations were taken with great care, and every thing got in readiness for the day's work. Day broke

threatening and cloudy, but cleared up at 3 o'clock and stayed clear till all was over. All four contacts were successfully observed. The first contact occurred at eleven mimutes after 3 and the last contact at nineteen minutes after 5, local mean time. The duration of totality was 2 minutes and 30 seconds. The corona was seen in its lower layers entirely surrounding the sun and extending in two great flashes or tufts of auroral light from the east and west limbs. Wilson observed three large prominences, not pink or red, but of a mother-of-pearl tint, and of vast magnitude. The contacts were observed with the spectroscope, and seen sharply at that. Mr. Pulsifer witnessed the reversal of the Fraunhofer lines, and Seegrave saw line 1,474 and measured its thickness. Five photographs of unmistakable excellence were secured, and it is believed those taken with the polariscope will settle some important points as to the constitution of the corona. The spectroscopic observations confirmed those of Young and Harkness as to the continuous spectrum of the corona. Observations as to limit of shadow and duration of totality were taken by assistant observers at McKinney, Dallas and Bresmond. The whole expedition is considered an entire success in point of observations, pictures and sketches.

We are indebted to Prof. Lewis Swift, of Rochester, New York, one of the most distinguished astronomers in the country, who was with the Chicago *Tribune* party to visit the line of totality in the eclipse of Monday, for the following personal information in regard to that most remarkable phenomenon: The eclipse in many respects was not equal to that of 1869, owing to the fact that there was almost a total absence of protuberances. But as far as the corona was concerned it surpassed all modern eclipses. Some idea may be formed of the immense length of the coronal streamers, when told that the sun's diameter is equal to 850,000 miles and the length of the pencils of light that go to form the corona must, if they extend that distance, be each equal in length to 850,000 miles. The party sent out to Denver by the Chicago *Tribune*, consisting of Profs. Colbert, Hough and Swift, of Rochester, N. Y,, inaugurated a class whose special duty it was to draw the corona as it appeared to the naked eye. Over one dozen were drawn, and some drew them to the unheard-of length of over three times the sun's diameter, or equal to 2,550,000 miles. Prof. Watson claims to have discovered Vulcan, and Prof. Swift also saw the same object, but he makes the distance (by estimation) one half a degree greater and its brightness half a magnitude less. There can be but little doubt but that this hypothetical world has at length been found, thanks to the total eclipse and the zeal of our American astronomers. Two protuberances were seen, and those only near the end of totality. They were of the usual pink color, but very unique in shape, one resembling a hook, which must have projected 50,000 miles from the sun, and the other resembled the antlers of a deer. Bailey's Beads were distinctly seen and also the chromosphere, at that part of the sun which the moon uncovered three or four seconds before the end of totality. It is a layer of red-hot hydrogen, some two thousand miles in thickness, extending over the entire surface of the sun. It is from this layer that the protuberances are formed, which the spectroscope decides to be incandescent hydrogen.

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ECLIPSES IN THE PRE-CHRISTIAN PERIOD.

When the world was younger than it is now by many centuries, the eclipse of the sun, which will to-morrow be studied with the closest attention by men of science, and watched with an eager and intelligent curiosity by every one wherever it is visible, would have caused the greatest terror even in the most brilliant and highly civilized nations of the time. The lively Greeks and the unimaginative Chinese alike looked upon an eclipse of the sun or moon with awe-struck eyes. They believed it to be beyond the circle of the regular order of nature, a portent big with the presages of calamity and disaster impending over whole empires, republics and peoples Milton expressed this idea as prevalent among the ancients in the splendid imagery in which Satan is described in the Paradise Lost. The poet paints the form of the arch-fiend as one that had not yet lost "all its original brightness," and compares him to the light of day darkened:

> As when the sun, new risen,
> Looks through the horizontal misty air,
> Shorn of his beams, or from behind the moon
> In dim eclipse disastrous twilight sheds
> On half the nations, and with fear of change
> Perplexes Monarchs.

The dread and the awe it inspired were almost universal, and strangely enough their impressions were extraordinarily vivid among the Greeks They were felt by a nation that had given birth to a Homer, an Æschylus, and a Sophocles, and whose greatest historian is unexcelled even to this day. They influenced the leaders of the people as well as the masses even in the days when Socrates was teaching in the streets of Athens, and when a Plato and an Aristotle were writing their immortal works. The Athenians had shaken themselves free from many delusions, but the old mystic astrology they had acquired from the Egyptians and Chaldeans clung to them in this and many analogous forms long after they had learned to laugh at many of the tales of their gods. The singularity of the firm foundation of this belief in a people so acute and so subtle is yet heightened by the assertion, which found credit almost everywhere, that Thales, the famous Ionian philosopher, had predicted the great eclipse of the year 610 B. C. The Medians and the Lydians were then at war, and a fierce engagement was in progress when the shadow of the moon began to obscure the face of the sun. At first it was scarcely noticed, but long before the totality of the eclipse was reached both the armies, infuriated though they were by all the enmity of protracted hostilities were so thoroughly frightened that they laid down their arms, and when the sun again grew bright, to turn away the anger of heaven, peace was at once concluded and a marriage celebrated be ween the son and the daughter of the rival monarchs. Thales some years afterwards died, but his fame survived him, and yet in spite of this the Athenian superstition was the cause of innumerable woes from another eclipse. It was in the year 413 before our era, when their generals had determined to abandon the siege of Syracuse. The night they had

selected for sailing away from the ill-fated spot chanced to be a full moon, and when its beams shone the brightest over the city and the waters a lunar eclipse suddenly darkened all. The utmost consternation pervaded the whole camp, and the retreat, which would have saved them, was given up. In the morning Nicias consulted the soothsayers, and they unanimously declared that it was the will of heaven that the army should not move or attempt any new enterprise for thrice nine days. Nicias obeyed and lost army and fleet, and the eclipse thus prepared the grave of the Athenian hopes. Eighty-two years afterwards another eclipse threatened to arrest the career of one of the greatest soldiers the world has ever produced. The battle of the Issus had been fought, and Alexander in his triumphant march had forded the Tigris in pursuit of the main body of the army of Darius, and the moon, again at the full, was eclipsed in the sight of the wondering and awe-stricken Macedonians. The officers and the soldiers alike murmured against what they called the insolence of Alexander in opposing the will of heaven, thus manifested by the marvelous sign in the skies. They vowed that they would no longer tempt the gods by penetrating fatrher into an unknown and mysterious country. But Alexander was more cunning and made of sterner stuff than Nicias. He summoned his own astrologer and some Egyptian soothsayers he had with him, and induced them to declare that the sun represented Greece and Macedon, and the moon the Persians, and therefore the obscured disk heralded the defeat of Darius. They were believed, and by thus working upon their credulous belief in the augury he was enabled to pursue his victorious march.

The belief in the supernatural character of a lunar eclipse lingered indeed long after that of the solar became partially known. Artemis, whom the Latins called Diana, was the sister of Apollo, and as he was the god of the sun, her abode and her worship naturally enough came to be associated with that of the moon. Some of the Greeks, with lighter and airier fancies, imagined, therefore, that when her orb was darkened the goddess was absent in the mountains of Caria on a visit to Endymion, with whom she was chastely enamored. Others, whose minds were darker, thought that she had been temporarily dragged from her throne by the incantations of the magicians of Thessaly, the abode, in the opinion of all antiquity, of every species of unholy magic. This latter superstition was held by the Romans, and as soon as the outer rim began to be obscured they ran into the streets, and with the braying of brass trumpets, the clash of iron and the loud cries of women, they endeavored to drown the foul mutterings and the songs of the enchanters and so prevent their reaching or staying in the ears of Diana too long. Some, indeed, believed that if she stayed in Thessaly too long she would never return, and thus night would be forever deprived of its brightest luminary. Juvenal alludes to this tenet of the popular faith when, after sarcastically describing a blue-stocking and strong-minded woman of his day, he says that she made noise enough in her arguments, harangues and commentaries upon the poets, to aid the moon in her troubles without assistance from any one else. This idea of averting the consequences of an eclipse by a noise might well serve Sir

John Lubbock and other scholars as an additional argument for the common origin of all nations. It was entertained not only by the Greeks and Romans, but also by the Chinese. Their theory was that a huge winged dragon caused the darkness by attacking and attempting to devour the sun, and whole villages turned out to beat the gongs and make a horrible din with the clang of their voices and the clash of all the instruments they could procure, and thus drive the dragon off. When the fairest regions of the earth became Christendom, all these foolish fancies of the old world faded away. Something akin to them lingered long in the remoter villages of Europe, and even now the unwonted veil cast over the face of the sun in the height of its splendor, often floods the mind of the imaginative with a not unworthy reverential awe. But now we are all more or less conversant with the real character and causes of an eclipse, and to wait with eager attention for the enlargement of the realms of knowledge by the very change in the heavens that struck terror into the souls of the intellectual Greeks, is not the least among the numerous proofs of the great and manifold gains which time has harvested in its progress from the old, pre-Christian days to this newer and enlightened epoch. —*Globe Democrat.*

CORRESPONDENCE.

SCIENCE LETTER FROM PARIS.

PARIS, June 20, 1878.

Has nature always appeared to man under the colors that we know her? Has man always seen the heavens, the trees, the sea, colored with the same tints as we perceive them? In the great theatre of the world, where the decoration and lighting change almost at each hour, has man ever been sensible to the same purple rays of dawn and sun-set, or the tender green of young vegetation? Certainly he has not. The infant is a parallel in point; with it the retina is developed very slowly, and from the centre to the circumference; it is caught by striking colors, but remains perfectly indifferent to vague and undecided shades. Prof. Magnus of Breslau, has just published a work, where he demonstrates that the idea of blue and green has not always been the same during the diverse periods of humanity; that the sense of colors has undergone a transformation, and consequently, the anatomical structure of the eye has changed. Indeed the Professor admits, that at a certain epoch, man felt light, without being able to distinguish the colors; the whole of the retina was then, what its circumference is now, insensible to color, or, where all colors lose their distinction and become confused in a grey, more or less clear. The eye is a *chef-d'œuvre* of nature, the most curious marvel to be perhaps encountered on earth, and hence its capital importance in all matters affecting organic evolution. Light is the excitation produced on organized matter by the mechanical vibrations of ether. The eye has been sensible to the

quantity, before being affected by the quantity of light, that is to say, the power of distinguishing colors. All animated matter, whether animal or vegetable, is sensible to the varied intensity of light. The petioles and leaflets of the sensitive plant become flaccid, when placed in lanterns of violet, blue, or green glass; they become stiff, when changed to a lantern of yellow or red glass. In the case of those microscopic animals, the daphnia, peculiar to ponds, Paul Bert enclosed a number of them in cracked vase. So long as they were left in the dark, the animals swam about indifferently, but the moment a spectral light passed through the crack, the animalcules rushed to the spot; now if the light consisted only of a single colored ray, the daphnia crowded in greatest numbers, as the rays are yellow and red, rather than blue and violet. By what physiological process does the human eye feel not only the quantity, but the quality of light, that is to say, distinguish colors? By the force, more or less strong, with which the ethereal waves shake the sensitive elements of the retina. Such is the cause, altogether mechanical, of the sense of colors. The red and yellow rays, are more perceptible than blue or violet, because they possess more energy and strength, when as ether-waves they strike the middle of the retina, leaving a profounder trace.

Dr. Tholozan, physician to the Shah of Persia, read a paper before the Academy of Science on diphtheria. He stated there is no name either in Persian or Arabic for this disease, and it is not known in Oriental history. It first made its appearance in the centre of Persia, in 1869, spontaneously; it has since attacked individuals in different parts of Persia, other than sea-ports, thus proving the malady has not been imported. Its effects are most disastrous in cold weather.

Paris has a new hospital at Menilmontant, containing 560 beds, each bed having 55 cubic yards of air. The four wings, containing the wards, are wide apart, and five stories high; the fifth story is a spare ward, into which the patients of different wards are conveyed to admit of that vacated being fumigated and cleansed periodically; there are lifts for all the stories, and large fire-places in each ward. Apart from the value of an open chimney as an agent of ventilation, the French surgeons find that a blazing fire produces a most salutary effect on the invalids, especially those capable to sit around it and chat. In addition, the *salles* are warmed by hot air. The wing devoted to *accouchements* has a distinct and separated room for each woman, following Dr. Tarnier's plan. The new hospital is the first in Paris, and far superior to that costly failure—the Hotel Dieu.

Not the least of the wonders connected with the Exhibition, is the building itself; in the 1867 palace, owing to its demi-circumference form, the iron employed could only be afterwards sold as old metal. In the present structure the pieces can be sold without any loss; indeed the building might be taken down and re-erected in any city in the world. The subsoil of the Exhibition is a marvel; it consists of a series of double passages—containing 5,000 pillars some ten feet high —for the purposes of ventilation, gas and water pipes, etc. It is a city of tombs —catacombs under another form. At every twenty yards are ladders, pick axes, etc., so that in case of fire, a guardian has only to raise a trap-door in the floor,

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turn a cock, and help himself to all the appliances of the fire brigade. It is in these pillars that the water from the roof of the building is conveyed into the central sewers. The air entering under the grand vestibule is cooled in its circulation along the catacombs, out of which it escapes through the interstices of the flooring, being sucked up by the vane arrangement of the roof; but as the latter is lined with sheeting to blind out the sun, the ventilation of the Champ de Mars leaves much to be desired. So far however, the rain has been more general than sunshine.

Another point deserving of notice, is the splendid span-work, in the roofing of the vast machine galleries. Up to the present engineering has produced nothing so bold, combining lightness, width and strength. The cold and severe lines of the iron structure have been happily relieved by the adoption of the old plan of ceramic decoration; the fantastic coloring of the faiences produces a very agreeable effect.

The sea is agitated by three kinds of movements; currents, ground swells, and waves. The second consists of long undulations, which never break into foam, and are produced by the impulsive action of winds blowing at a great distance and developing only an undulatory motion checked by a calm, or an opposite wind. The swell is very inconvenient from the rolling effects it produces on the ship—and unhappily, on the passengers. M. Bertin has resumed his studies on waves—their height, length, and duration. Admiral d' Urville gave the greatest altitude to waves; as much as 108 feet he estimates some off the Azores in 1820; but Arago roundly asserted the measurement was inexact and considered 26 feet the maximum elevation. M. Bertin agrees with Arago, while averring that waves 39 feet high are infrequent, and those of 60 very rare. The length of a wave may vary from 120 to 140 yards—M. Mottez says 450 yards—and their duration from 23 to 28 seconds. Pending squalls in the Bay of Biscay, by the aid of the oscillometer, M. Bertin determined that the duration of the rolling of a vessel is constant for the same ship and for the same state of its cargo, no matter what may be the intensity and the duration of the succession of the waves.

Dr. Rizzoli, an Italian, relates a singular circumstance connected with an infant, who fifteen days after its birth had a tumor on the small of the back, out of which was growing a tuft of hair two inches long. By means of compression, he reduced the tumor in the course of a year, but the tuft of hair, similar in color to that on the head, continued to flourish. The girl is now seven years old, enjoys perfect health, and the tuft of hair, color changed to chestnut, extends to her knees.

Dr. Couyba, of St. Seirade, has had under his care a cabinet maker who suffers from the mania of a desire to kill somebody and the torture resulting from his efforts to not commit murder. The patient is 21 years of age, and when seven years old he was brought to witness an execution; since then his malady. The doctor compelled him to relate his history, and by prescriptions of phosphuret of zinc has completely cured him. The same medicament has been employed by other

practitioners, and with success, to treat melancholy and several forms of hypochondria. From the horror of the *vide* to the horror of space is but a step. Dr. Raggi, of Bologna, has been attending a young artist who threw himself off a roof. It is customary in Italian cities, when a prize or sizarship is to be won for painting, to shut the candidates up in the Academy and then give them the subject for competition. The young artist in question had nearly completed his remarkable picture, when, seized with the horror of being confined, he dropped from a window to a roof, and jumped thence into the street.

M. Saudry, Professor of Palæontology, has discovered an enormous fossil animal, belonging neither to the crocodile nor exactly to the plesiosaurus families. He names the animal "Eurysaurus," on account of largeness of its head. The remains were found in the lower oölithic formation near Veroul. The enormous reptile had large conical teeth protruding outside the head.

M. Toussaint, has expounded before the Academy of Science, a study on the process of rumination. He states that it is not a ball of the half masticated food which returns to the mouth, but a mouthful of liquid holding the aliments in suspension, the ascension being due to the vise relatively existing in the thoracic space.

Dr. Dunant deplores the social phenomena which tends more and more to attract the rural population to live in cities, a fact lamentably prominent in, but not peculiar to France. Charles V. wrote to Francois I., in the sixteenth century, when this movement or immigration first manifested itself: "Forget not this truth, my brother, the capital where the necessitous classes dominate by number, will infallibly become the tomb of royalties and of great nations." Dr. Dunant proves that the increase in the population of the cities of France coincides with the decrease of inhabitants in the rural districts. It is estimated that the rural element in the urban population is about four-fifths; the population of Paris is two millions, not more than one-fourth of this number are to the manor born, and were it not for this annual steady flux of country people to the capital, citizens would physically die out. In the three most populated departments of the country, in order to obtain 1,000 sound conscripts, 1,790 men must be examined; while in three departments the least peopled, 2,270 have to be examined. The cities where immigration is most marked are weakest in birth rates, but the few marriages that take place are characterized by superior fecundity, The sum total of vice in all cities is nearly equal; it differs chiefly in form. The rurals that come to reside in cities suffer more from diseases than natives, because exposed to less pure air and less healthy food.

M. Baranger has practiced medicine for many years in Russia. In the humblest household is to be found a bath for children, made from a portion of a poplar tree, scooped, and babies are accustomed to a cold bath from their earliest age. The doctor's work is addressed, not so much to young mothers, as to young practition-

ers. For the new-born child three conditions are necessary: pure air, mild and equable temperature. To wet nurses, he counsels that they be fed as much as possible, following, while varying, the regimen to which they have been accustomed, avoiding a too succulent fare, which speedily fattens nurses while diminishing their supply of milk.

If the great movements of the atmosphere were known to us, that is, if we could discover the laws of their formation and direction, meteorology would become a science as exact as chemistry. M. Tissandier, the noted aëronaut, contributes some interesting meteorological facts. The clouds are suspended in the atmosphere in layers or fields, of thickness varying from 220 yards, and at heights from 1,7000 to 4,000 yards. The atmosphere is frequently separated into two distinct portions by strata of clouds, the upper portion may be quite pure, while the lower engenders rain or hail. The pure, upper regions, hold often in suspension spangles of ice, which shine like needles in the sun's rays; there are thus not only ice clouds but layers of crystalline snow. The clouds near the surface of the soil are not only variable, but their aspect changes following the latitude of a country. In the upper regions of the air, the watery vapor rarely moistens the skin: the contrary is the case with fogs at the surface of the soil, but which are only a special form of vapor. There are layers of clouds that are transparent vertically, but not so when viewed horizontally. F. C.

COLORADO NOTES.

Prof. C. E. Robins, writing from Summit, Colorado, July 20, alludes to the REVIEW very complimentarily, and says: "I read with much interest and high approval, the article on National Defense and Military Education, by my old friend, Captain Trowbridge. It is every way admirable. I must, however, take leave to differ wholly from Prof. Mudge—fourth paragraph on page 174, same number of the REVIEW—since both insects and butterflies abound at 12,500 feet in this district to-day. Honey and mason bees, I think, are here; "bumble bees" (*Bombus*) I know are, having only last week come into personal contact with the business end of one. Six of the nine subsections of the class Insecta are represented here, and I am by no means sure that *Coleoptera*, *Neuroptera* and *Myriopoda* are absent. I only have not noticed them. *Lepidoptera* is well represented. *Pieris oleracea* and *Colias philodice* have been seen since the 28th of June. *Bombus* was first observed on the 25th.

The weather is perfect here, 72° being the highest temperature, so far, of the month. I counted yesterday twenty-one snow fields in sight on South Mountain (one 12 feet deep), and thirty-one on North Mountain (Summit Peak).

I have arranged two parties of observation of the solar eclipse on the 29th, one for top of South Mountain, the other, under my personal direction, will take the situation from the triangulation monument on Summit Peak. Have full instructions from Gen. Myers, and if the afternoon is fair expect an interesting time.

COMMERCIAL VALUES OF FOREIGN COINS.

TREASURY DEPARTMENT, OFFICE OF THE DIRECTOR OF THE MINT.

WASHINGTON, D. C., July 22, 1878.

COL. T. S. CASE:

SIR: I have received your letter of the 19th instant, enclosing newspaper slips, relative to the value of the Mexican silver dollar, and requesting information as to the correctness of the statements.

The St. Louis *Times* states that the value of the Mexican dollar was fixed by the Government, Jan. 1, 1878, at 99.8 cents, and is received by the Government at that rate. The Mexican dollar is not receivable by the Government. Section 3584, Revised Statutes, declares that "No foreign gold or silver coins shall be a legal tender in payment of debts." Treasury Circular No. 1, a copy of which is herewith transmitted, fixes the value of the Mexican silver dollar at 99.8 cents as compared with the U. S. Trade dollar.

The valuations given in this circular have no reference whatever to the value of the coins for circulation, but are for the purpose of changing into our money terms for custom purposes, invoices of foreign merchandise, that may be made out in their respective currencies.

Mexican dollars, having no legal tender in the United States, have therefore only a value as bullion, which fluctuates with the price of silver bullion. At current rate, the bullion or intrinsic value of the Mexican dollar, if of full weight and fineness, is about 91 cents, gold, per piece. The full legal weight is 417.-790,536 grains, and the fineness 902.777.

It is the legal tender qualification of the standard silver dollar of 412½ grains, 900 fine, that gives it for circulation its full nominal value, otherwise it would have merely a bullion value, which, at current rate for silver bullion, would be 89.43 cents gold. Very respectfully, H. R. LINDERMAN, *Director.*

Circular exhibiting the values in United States' money of the pure gold or silver representing, respectively, the monetary units and standard coins of foreign countries, in compliance with the act of March 3, 1873.

1878.
Department No. 1.
Secretary's Office.

TREASURY DEPARTMENT,
WASHINGTON, D. C. Jan. 1, 1878.

The first section of the act of March 3, 1873, Statutes at Large, volume 17, page 602, reproduced in Section 3564 of the Revised Statutes provides "that the value of foreign coin, as expressed in the money of account of the United States, shall be that of the pure metal of such coin of standard value," and that "the values of the standard coins in circulation of the various nations of the world shall be estimated annually by the Director of the Mint, and be proclaimed on the first day of January by the Secretary of the Treasury.

The estimate of values contained in the following table has been made by the Director of the Mint, and is hereby proclaimed in compliance with the above-stated provisions of law:

COUNTRY.	MONETARY UNIT.	STANDARD.	VAL. IN U. S. MONEY.	STANDARD COIN.
Austria	Florin	Silver	.45,3	Florin.
Belgium	Franc	Gold and silver	.19,3	5, 10 and 20 francs.
Bolivia	Dollar	Gold and silver	.96,5	Escudo, ½ bolivar, bolivar.
Brazil	Milreis of 1,000 reis	Gold	.54,5	None.
British Possessions in N. Amer.	Dollar	Gold	$1.00	
Bogota	Peso	Gold	.96,5	
Central America	Dollar	Silver	.91,8	Dollar.
Chili	Peso	Gold	.91,2	Condor, doubloon, escudo.
Denmark	Crown	Gold	.26,8	10 and 20 crowns.
Ecuador	Dollar	Silver	.91.8	Dollar.
Egypt	Pound of 100 piasters	Gold	4.97,4	5, 10, 25, 50 piasters.
France	Franc	Gold and silver	.19,3	5, 10, 20 francs,
Great Britain	Pound sterling	Gold	4.86,6½	½ sovereign, sovereign.
Greece	Drachma	Gold and silver	.19,3	5, 10, 20, 50, 100 draehmas.
German Empire	Mark	Gold	.23,8	5, 10, 20 marks.
Japan	Yen	Gold	.99,7	1, 2, 5, 10, 20 yen.
India	Rupee of 16 annas	Silver	.43,6	
Italy	Lira	Gold and silver	.19,3	5, 10, 20, 50, 100 lire.
Liberia	Dollar	Gold	1.00	
Mexico	Dollar	Silver	.99,8	Peso or dollar, 5, 10, 25, 50 centavo.
Netherlands	Florin	Gold and silver	.38,5	Florin; 10 guldens, gold, ($4.01.9.)
Norway	Crown	Gold	.26,8	10 and 20 crowns.
Peru	Dollar	Silver	.91,8	
Portugal	Milreis of 1,000 reis	Gold	1.08	2, 5, 10 milreis.
Russia	Rouble of 100 copecks	Silver	.73,4	¼, ½, 1 rouble.
Sandwich Islands	Dollar	Gold	1.00	
Spain	Peseta of 100 centimes	Gold and silver	.19,3	5, 10, 20, 50, 100 pesetas.
Sweden	Crown	Gold	.26,8	10, 20 crowns,
Switzerland	Franc	Gold and silver	.19,3	5, 10, 20 francs.
Tripoli	Mahbub of 20 piasters	Silver	.82,9	
Tunis	Piaster of 16 caroubs	Silver	.11,8	
Turkey	Piaster	Gold	.04,3	25, 50, 100, 250, 500 piasters
United States of Columbia	Peso	Silver	.91,8	

The above rates will be taken in estimating the values of all foreign merchandise made out in any of said currencies, imported on or after January 1, 1878. I am, very respectfully, JOHN SHERMAN, *Secretary of the Treasury.*

THE INSCRIPTIONS ON MEXICAN DOLLARS.

KANSAS CITY, August 7, 1878.

Editor Western Review of Science and Industry:

SIR:—Having had some communication with Senor Romero Paferio, Superintendent of the republican mint at the city of Mexico, in reference to the inscription upon the obverse of the Mexican dollar, I herewith give you for publication the facts obtained from him. The coinage is almost, if not entirely, confined to the owners and proprietors of the heavy gold and silver mines throughout the several states of the Republic who are empowered and given full authority by the government to coin all bullion by them received into standard coins of the Republic; the law, however, compelling them to stamp all such coins with the value of the coin, place of coinage, date, assayer's name and fineness of metal. In pursuance of this law I give a complete list of the readings and translations of the dollars of 1878, the only additional information necessary being that eight reales equal one peso or dollar, and ten dimes, or twenty granos, are equivalent to nine hundred and three parts of silver to the one thousand

INSCRIPTION AND TRANSLATION.

CITY OF COINAGE.	VALUE.	INITIAL OF CITY	DATE	INITIALS OF ASSAYERS.		LEGAL FINENESS.
Mexico . . .	* 8 R.	M.	1878	M.	H.	10 D.^{S} 20 G.^{S}
	8 Reales	Mexico	"	Medina	Hermosa	10 dineros 20 granos
Oaxaca . .	* 8 R.	O.^{A}	1878	A.	E.	" "
	8 Reales	Oaxaca	"	Augustin	Endner	" "
Guanajuato . .	* 8 R.	G.^{O}	1878	F.	R.	" "
	8 Reales	Guanajuato	"	Fran'coSardaneta	Ramon Mendoza	" "
Zacatecas . .	* 8 R.	Z.^{S}	1878	J.	S.	" "
	8 Reales	Zacatecas	"	Jesus	Santa Anna	" "
San Luis Potosi	* 8 R.	P.^{I}	1878	M.	H.	" "
	8 Reales	Potosi	"	Manuel	Herrera	" "
Guadalajara . .	* 8 R.	G.^{A}	1878	J.	A.	" "
	8 Reales	Guadalajara	"	Julio	Arancivia	" "
Durango . .	* 8 R.	D.^{O}	1878	P.	E.	" "
	8 Reales	Durango	"	Pedro	Espejo	" "
Chihuahua . .	* 8 R.	C.^{A}	1878	A.	V.	" "
	8 Reales	Chihuahua	"	Antonio	Valero	" "
Culiacan . . .	* 8 R.	C.^{S}	1878	J.	D.	" "
	8 Reales	Culiacan	"	Jorge	Douglas	" "
Alamos . . .	* 8 R.	A.^{S}	1878	D.	L.	" "
	8 Reales	Alamos	"	Domingo	Larraguibel	" "
Hermasillo . .	* 8 R.	H.^{O}	1878	J.	A.	" "
	8 Reales	Hermasillo	"	Jesus	Acosta	" "

Yours respectfully,

H. P. CHILD.

METEOROLOGY.

A NEW VIEW OF THE WEATHER QUESTION.

BY ISAAC P. NOYES.

(*Continued from the July number.*)

LII. The best portion of the United States for regular conditions to follow each other seems to be east of the Rocky Mountains. It has sometimes been said that our storms come from the Rocky Mountains, but from the weather maps and the natural laws that *low* appears to follow, it would seem that they do not generate anywhere in particular, and are liable to generate at any portion of the Earth's surface; indeed, there is a constant struggle at every point—the strongest force prevails and a small *low* is sometimes, as it were, swallowed up by a larger one and borne on by it, or at times to even develope within a very extended one.

LIII. There are general and local laws, and this accounts for places near each other having currents of wind in even opposite directions, and for the fact while the general wind is in one direction, a local wind may be in another and even just the reverse. In such cases, however, the wind will not generally be very heavy.

LIV. "POLAR WAVES."—This is a nice expression, yet strictly speaking there

is no such thing; the laws that govern the system do not warrant the use of it, at least otherwise than in a figurative sense, for to the north of us there is evidently another line or lines, as it were, of *lows*, running in all directions as generally in the territory of the United States; and to the north of what is here called a "polar wave," there are undoubtedly warmer circles at the time than in the current of this "wave" that is supposed to be, or, as its name implies, is all the way from the icy North, for the reason of there being another center of *low* away up there, whereby in that north latitude local south winds are generated. We learn from Arctic voyagers that the wind up North at times blows from the South, as well as at other places on the Earth's surface; perhaps not as much, yet it does so blow, and this will reasonably account for it and is evidently the reason for it. At the North they might as well have the expression, "an equatorial wave," and it would be just as proper as to say a "polar wave," at least in this sense.

LV. The condition *low* is, as has been remarked, the controlling power—where *low* is there will the wind be concentrated—toward these centers the currents will be established. When (North of the Equator) a North wind blows, it will necessarily be cold, unless, perhaps, as in cases where the *low* is not very positive, and the wind is light and must travel over extended plains, as occasionally in summer, as herein referred to. This, though, is only an illustration of the predominance of the stronger factor. And when a North wind blows it will be on account of a low barometer area at some point South, and not, as is sometimes thought, because of a condition of high barometer up North. A condition of *high* does not push on a current but a condition of *low* pulls along the current; in other words, wind is pulled, not pushed.

LVI. The territory in the United States embraced between that portion of the Rocky Mountains running N. W. and S. E. and S. W. and N. E., Salt Lake City being its eastern angle, and the "Blue mountains" running N. E. and S. W., and the Sierra Nevada mountains to the S. E. and N. W. (see plate B), which has an elevation of from 4,000 to 5,000 feet, seems to have, as it may be termed, a "condition" by itself and to have its own local *lows*, as it were, cut off by the mountains. There are, however, few stations in this locality, so the world is not at present fully informed of its changes; yet, from the observations taken at its four quarters—Salt Lake City, Boise City, Pioche and Humboldt City—the conditions *low* seem to be local. The strip of territory between the mountain range and the coast has quite a different climate from the rest of the United States. California has a peculiar weather condition. If these mountains are the cause of this, it may be asked, why does not the Blue Ridge and the Eastern ranges of mountains affect the Eastern climate? They undoubtedly do, but not in this manner, for *low* seems to travel without much regard to them. They are lower, less extensive (horizontally) and are, as it were, set in the midst of fields, whereby their influence for chilling the air is counterbalanced. On the Pacific slope, however, we have a high and extensive range of mountains that cools the air, thus affording a check to the further development of *low* across them. But for these high and mountainous regions, *low* would undoubtedly

travel directly across the land, start in at the Pacific shore and travel regularly—depending on the force of the heat and neutralizing influences—with more or less rapidity toward the Atlantic coast. But the coast range, backed by the high plateau country as far West as to include the Rocky Mountains, makes quite a different condition of climate for this territory from what it would be if it were comparatively level. To illustrate, say *low* is developed on the land; it is checked in its course eastward by the coldness of the mountain airs and is, as it were, shut off from the East. So, in a similar manner, the *low* that is developed in what may be termed the mountain quadrilateral, but with the territory to the East of the Rocky Mountain range it is altogether different. Here *low* has a broad and comparatively uninterrupted field through which it travels as it wills, or as the Sun will dictate, sometimes starting here and sometimes there. (See plate.)

LVII. The higher the Sun works up, *generally*, the higher the line of *low*, and the reverse; and the more concentrated and positive the *low* will be in these upper or lower latitudes. (Reference is now had to North latitude.) So we see that the North winds prevail in the winter and the South winds in the summer. This a general law and not a special one, that necessarily follows the Sun in its course North and South of the Equator. We do, however, have centers of *low* running quite high during the winter, and this causes South winds and warm weather; when the reverse and *low* is low, we have severe cold winters. Because in the United States or in any parallel of latitude they have a warm winter or cool summer, it does not imply that the weather to the North of this line will be correspondingly affected; it may or may not; may be correspondingly colder or warmer, all depending on the line of *lows* in these regions, which may be quite independent of those to the South of them.

LVIII. As to cold winters and warm winters, it seems a matter of mere accident, so far as we know, yet of course beyond us there may be a Providence in the matter that has special reasons for such a condition of things, but so far as our knowledge reaches it appears to be the merest accident, as the location of *low* itself. *Low* starts at a certain point; it must continually seek new fields; and it is a wise law that it should, even though it may sometimes come around to locations that cause weather that to us appears out of season. This being the case, it seems very plausible to me that it must be irregular in its time and place, and that it is liable to be constantly overlapping itself, so that after a number of years it gets around to certain localities, causing atmospheric conditions that would not seem natural for a given locality, being cold when our months should say warm, and warm when they should say cold. But nature is nature, and it seems in accordance with herself to have her continually, as it were, overtaking herself. She is all the while obeying the strongest force, either positively or negatively. If our seasons in the course of periods change so as not to accord with the present names of the months, it will be in accordance with this principle—and it may account for many changes in the past history of our Earth that cannot otherwise be accounted for. The greater or less amount of water present

has much to do with this matter of climate. We know that there is evidence in past ages of the world, of some northern localities, at least, being much warmer than at present. We also know that eruptions have occurred, and that whole tracts of country have been raised above the surface of the water. As the effect of the sun's rays on the water is peculiar and different from their effect on the land, may there not have been conditions that have made localities relatively different from what they are now. This idea of Nature, as it were, gaining on herself, even though slowly, may also give the color of reason to the idea that the earth is gradually changing—that no one point is permanently relatively fixed with any outside body—and may not the same idea extend to the whole universe? It would not seem unnatural; what may account for a small thing may also account for a large one. All nature works on a similar plan and after the same general laws.

LIX. Low barometer centers in the ocean. The chances are that *low* is distributed over the ocean in a similar manner as on the land. The fact that vessels at sea have the wind from all quarters, meeting with storm centers and calms, and have the wind to shift from one point to another, would evidently, beyond doubt, go to prove that such is the case. This, however, would go to disprove the poetical idea that the waves beating on any given point, say on the rocky shores of New England when the wind in to the eastward, are all the way from the shores of the Eastern continent. It is very improbable that they are ever from such a distance. The chances are that there are a number of low barometer centres between the two continents, and that the wind that raises the seas that strike against the New England shores, starts not more than from two hundred to five hundred miles away, and perhaps not always at as great a distance. The force of the ocean wave is not altogether in the distance that it has to travel, though it does require quite a distance in which to raise a heavy sea; the force of it, however, must depend upon the force of the wind, which in turn depends upon the power of *low*.

LX. Clouds.—In the Signal office at Washington there is a large case in which the weather of the earth is illustrated in miniature. The clouds are formed of cotton and are nicely and artistically executed; the different kinds are true to nature, from the most delicate clouds that are first formed, to the heavy black clouds that produce the heaviest rains. The whole case is a wonder of handiwork, wherein the whole meteorology of the earth may, to the initiated at least, be seen at a glance. It is not the purpose of this article to more than refer to this; it would seem, though, that every college in the land, and every high-school, should have such a model, as by it this subject of the weather can be studied with great advantage. Certain conventional names have been given to the different kinds of clouds. Of course there are all kinds, from the very light to the very heavy, and these can be seen merging into one another without any respect as to the name they bear. However, it is well to know them by the established names, for thereby we not only have the pleasure of knowing them

better, but we can the better describe them and gather information in regard to the weather by their form and combination, etc.

LXI. WINDS.—The winds are governed by the condition *low*, and therefore the governing condition has been spoken of first; yet the two are inseparable, and are only here apparently separated because language will not allow us to speak of two things at once.

LXII. The force of the wind depends upon the power of *low*.

LXIII. The direction of the wind will generally be toward *low*: it may be deflected by local forces, for the local is ever contending against the general, and the reverse. This has been referred to under the head of *low*. The harder the wind the more direct it will blow toward the center. It has been said that if we will stand with our left hands toward the region of *high*, and our right toward the region of *low*, that the wind will be in our faces; but the weather maps do not seem to warrant this as a general fact, though when there is a very large circle of *low*, and therefore not concentrated, such at times may locally appear to be the case. If there is anything in the idea of the conditions of low as herein spoken of, it would seem natural that the currents of air should generally be in towards the centre *low*. The daily weather maps seem to warrant the assertion and to be in full harmony with it.

LXIV. As to the force of the wind, it all depends upon the rapidity with which it is moving, and the rapidity depends upon the positiveness of the condition known as *low*. It is, however, subject to natural forces in a similar manner to more materialistic things, water for example.

LXV. It will be more or less retarded by friction, and over the sea there will be less friction than over the land and less over level tracts than over uneven and mountainous districts.

LXVI. As the wind will travel in as straight a line as possible, we can oftentimes, by observation as to the direction of the wind, trace the course of *low*, and form an approximate idea as to its probable locality. Occasionally there is an apparent exception as to the course of the wind towards *low;* for example, we sometimes have quite a cold south wind. This, however, will be found to be only local, and that such a south wind is in reality a west wind, with simply a changed direction for a comparatively short distance—changed by some local condition, such as a struggle to develope a sub or local *low*, or occasioned by some natural lay of land, such as the presence of a body of water, a mountain range, etc. An illustration of this effect may often be noticed in a city; though the wind may be blowing from the northwest, it may eddy or be deflected around some corner and blow (locally) from the southwest or even south. Because in this confined locality the wind was from the south, it would not be right to say that it was a south wind.

LXVII. Old people often speak of the wind going around from one quarter to another "with the sun." Such observations are oftentimes made and transmitted from generation to generation, yet without reason. People see that a storm comes, passes and clears off in a certain manner, but it was not until

within a very few years that we could trace a storm over such a vast area as the United States. Now we see why the wind should come up in a certain manner and pass around to another quarter, and so on till it comes out finally with the wind from another direction, and clears off; and why the wind is ever going from one point of the compass to another, and why a storm is liable to come up with one wind as well as with another.

LXVIII. It is a common thing to hear that "the wind is blowing up a storm." It may seem contrary to the wisdom of the past to deny that the "wind blows up a storm," yet from the remarks on the condition, *low*, it must seem obvious that the wind does not blow up a storm, but rather that, if anything, the reverse of this is more true, that the storm raises the wind. A *low* is developed, the wind rushes in to fill the vacuum. If *low* is, say in the middle of the United States, to the west of the same, the wind will be from the west; while to the east of the condition, the wind will be generally from the east: and if it passes to the south of a certain point, the wind at that point would be from the north, and the reverse if to the north. So the manner in which the vane turns will depend upon the relative location of the center of the condition *low*, toward which the wind will always blow. This can be better traced by reference to the map or plate.

LXIX. Then an east wind is generally considered a very stormy one with us, yet it is purely accidental, and we sometimes have exceedingly pleasant and clear weather with an easterly wind, for the simple reason that *low* is traveling to the west of our particular locality, and may pass us by altogether without producing a storm in our immediate locality. The greater part of the time, however, an east wind is caused by *low* being in the line of our locality, then the clouds that have been generating for days over the Atlantic ocean are brought to us and we have rain in abundance, and all the effects derived from the condition of low barometer. Yet in this connection it must be remembered that what may be a northeast storm in one locality, will to another locality, on some other side of *low* be called a storm from another quarter, i. e., a condition *low* is circular, and the storm converges toward it from every direction. This center may not be an exact circle or even approximate thereto, for oftentimes its real outline is anything but circular. The term circular is here used only in a general sense.

LXX. When there is a very positive *low*, a fierce wind is developed, and as the sun first strikes the east, the storm will travel generally in that direction, and as the wind will be from all directions toward this center, an elastic medium of air is established, as it were, as a cushion for the wind from each quarter to receive and be received upon, whereby the force of tornadoes are checked; otherwise they would do far more damage than they do.

LXXI. Much has been said about equinoctial storms. People have an idea that when the sun "crosses the line," that there must be some extra commotion whereby a great storm is generated. In regard to this, I will venture the assertion that there is no such thing as an "equinoctial storm." Any storm that occurs within two weeks, before or after, is commonly given this name; because

such a storm happens, and is always liable to happen, somewhere about this time, it is no sign that the "equinox" has anything to do with it. Storms are liable to generate at all times, one may occur at this particular time, and that, too, in merely certain localities, when it is perfectly fair at others. This being the case it seems absurd to thus connect it with the sun passing over a certain imaginary line.

LXXII. Rain and snow are essentially the same. This need not be told the initiated, yet there are people who think that the Signal officer has made an error when it is said that "it will probably rain," and it snows instead. It is a mere difference between a few degrees of temperature, and perhaps local temperature at that; if warm it will rain, if cold it will snow.

LXXIII. It is sometimes remarked, that it *feels* like rain or snow, but that it is too cold. In this case the clouds that contain this moisture are present, but if warmer a little beyond, they will pass along to that warmer spot. The strongest force, whether it be heat, cold, or wind, will predominate; the merely local must (generally) give way for the general or extended conditions.

LXXIV. When *low* extends over a large territory, or we are in the center of a concentrated one, the rain will come down straight or nearly so; but when the center of *low* is to one side and a fierce wind is rushing in toward it, carrying heavy clouds along, the rain will come down at an angle; the more fierce the more obtuse the angle at which the rain will fall, and sometimes the wind is so powerful as to make it come down almost horizontal.

LXXV. Trade winds and hurricanes we have not much to do with in this latitude and longitude, yet they, with other conditions, must obey the general law of air seeking an equilibrium. It would seem from what we know of the laws of storms in general, that the "trades" should, as they do, prevail in the latitudes nearest the equator, and that hurricanes should predominate in the same localities.

LXXVI. The manner in which a fierce wind travels has been much commented upon. It is said that it travels, as it were, in epicycles—going comparatively straight or in an elongated curve for quite a distance, then taking a sudden turn in the shape of a small circle, as is sometimes the case with dust in the street. This, however, does not accord with the *general* law, though the air, like the heavier material water, is evidently turned in this manner by local inertia. The more fierce the wind the more compact and the more it is liable to be deflected or swept around in a circle, the same as water, by any resistance that it may meet with. Its inertia of speed forces it on—the inertia of fixed objects, even though small, must cause some compromise—must be overcome.

LXXVII. Tornadoes look black, and oftentimes much resemble a huge serpent rushing over the ground. It would seem to be comparatively easy to account for this. The fiercer the wind the more condensed, and as it moves over the earth at the rate of a hundred miles or so an hour, it will necessarily take up with it much loose earth, dust, etc., whereby darkness of color is given to the whole mass. Then as to its serpentine form, the very compactness will

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account for that. The more compact, the more it holds together and becomes a thing of life, having elasticity whereby it may be deflected by one object to such an extent as to pass entirely over or by another object beyond, either horizontally or perpendicularly; thus, up or down, to right or left, it sweeps along on its course, taking as straight a line as possible, yet even in its most fierce condition being obliged to compromise its course more or less, bearing evidence to the law that the strongest force must prevail and showing that some mere local inertia is strong enough to deflect it from the straight line in which it seeks to travel. It is said, sometimes, to rain all sorts of things—sticks, stones, frogs, etc. A tornado, moving at such a fierce rate, is liable to take up and carry along with it any such small things, and when there is a lull in the wind or anything tends to retard it or sufficiently check its velocity, these objects that were taken up will fall to the earth, and in that locality we will have a "shower" of sticks, stones, frogs, etc., although, strictly speaking, the term "shower" will not be appropriate.

LXXVIII. Wind has not much force until it, by great velocity, becomes much compressed and gains, as it were, solidity.

LXXIX. At times the air is very oppressive, in common phraseology, called "muggy." This occurs when *low* is being developed or we are on the outskirts of an extended condition of *low*. The atmosphere is full of moisture displacing air; in addition to this, the air is quite stationary; there is no new supply, or a very little, coming in from other quarters—the allowance of air is small. As soon as precipitation takes place, or *low* becomes concentrated or moves on we get a bountiful supply of air, which, in contrast, is very refreshing.

LXXX. West winds seem to prevail with us, the cause being that *low* is more off in the ocean than on the land. Water heats quicker, the land retains heat the best. This will account for the constant changes, under some circumstances, such as night breezes and day breezes, as occur along the shores of great bodies of water.

LXXXI. Probably the best place for comfort would be between *high* and *low*; here we get a good breeze; we are, as it were, *in the current*, where the ventilation is generally perfect—occasionally there is too much rapidity for some local comfort, but we must reconcile ourselves with this when we know that it is carrying great comfort to another quarter, restoring balance of air or temperature to our fellow men in some other locality.

LXXXII. In the summer, especially the latter part, we have the wind much from what the Indians practically called the "sweet Southwest." This is occasioned by a moderate low barometer up in the Northeast, perhaps off New Foundland's banks, that region of fogs and mists. Had the Indians known the meteorological facts of the present day they would have had reason to have given this sweet name to the northeast rather than to the southwest—to the quarter that drew the currents on, rather than to a quarter from whence they were collected. The "sweet Southwest," however, at least along the Atlantic coast, is a most refreshing wind, bearing with it the tempered conditions of the West and South

and the effects of land and water; it was indeed beautifully and appropriately named by those sons of nature whom we term Indians. At this season of the year these winds are peculiar, in that they rise with the sun and die away with it, conclusively showing that heat is the cause of the wind. Though the wind dies away with the sun it very soon springs up again, and this may seem to controvert the theory, but instead it only substantiates it. The wind springs up but veers to the south or southeast, according to the trend of the coast, this being caused by the better retention of the heat by the land than by the water. During the day it is on the water, up off the northeast coast. The night cools the water, the land retains the heat, so a current is established landward.

LXXXIII. Later in the season, and indeed, earlier too, *low* is for much of the time still off in the ocean, but in a lower latitude, generating a northwest wind, causing fierce storms in the neighborhood of that storm centre off the coast of Hatteras, lying between there and the Bermuda Islands, in the locality by sailors called the "Devil's Corner." Sailors oftentimes have very expressive names for places and things. This is the locality where concentrated and even protracted *lows* are generated, therefore, a locality of storms; hence the name implying a very bad place—one to be avoided, and one where much caution must be exercised when necessity forces one to pass it. Yet this locality is not always deserving of this name; during the winter and spring months it would seem to be the most appropriate.

LXXXIV. UNDER LOW.—We see that low barometer is continually on the march, from point to point, from the land to the sea and from the sea to the land. After a storm has passed to the eastward the wind comes out more or less fiercely from the west; the sky is cleared of clouds; the wind hangs in this quarter for a a day or two, and, though cool at first, finally dies away, and in summer it comes out very hot and dry. These are probably the most trying days in summer, but this condition is not generally of long duration. *Low* is all the while as it were swimming 'round a circle of larger or smaller dimensions. Narragansett Bay in summer is a fine place to watch these changes. They generally occur about an hour or two after mid-day. At such times it is a common sight to see boats at different points sailing down as well as up the bay *before the wind*, though very little wind, and with a space of perhaps a mile or two between where it is all calm, with a slight flow of wind, first one way then another; the north wind and westerly wind receding and the southerly wind gaining, and by and by coming out a good breeze to the southwest. *Low*, in order to make this change, has the while been shifting, and perhaps the governing one in this case is located up in the northeast, just off the ocean.

The partial wreck of the steamer MASSACHUSETTS, while on her eastern trip in Long Island Sound, the early part of November, 1877, is a good illustration of the change of wind in a similar manner, yet more sudden. A heavy southeast storm had prevailed during the day. The captain of the steamer, in order to avoid running the risk of exposing his boat to the fierce winds and waves of the Atlantic ocean, had hugged the Long Island shore. It was very foggy weather,

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and so thick, as the sailors say, that no lights were seen from the shore. They were running by dead-reckoning, that is, by their knowledge of the speed of the boat, the force of the currents and general experience of navigation in these waters. As the steamer was, about 11 p. m., near the gate to the ocean, it was decided to turn the head around towards the west, and "stand-by" till morning. From want of exact knowledge of their situation, from not having proper data, the boat was accidentally run ashore on a projecting sand point. Had the wind remained to the Southeast, at the slow rate of speed at which the boat was going, this would not have been a serious matter, but soon after midnight, or thereabout, the wind suddenly came out to the Northwest. The captain now found himself, instead of under a lea, on a lea-shore and at the mercy of a fierce wind. What had caused the change? When we follow up the path of *low*, it is all as plain of explanation as the blowing of the wind itself. On the return of another day, the advancing heat of the sun out on the ocean had caused (or pulled) the center of *low* to the eastward, whereby the wind, that had been blowing toward this center from the northward and westward, was permitted to go into other fields, as it were, in order still to seek the point of *low* that it is all the while striving for. These changes are more or less sudden, depending on the power and concentration of *low* and the relation that it bears to a given locality.

LXXXV. In this connection there are a few other general points of illustration that it may be well to refer to. It is known that there is no regularity to the speed and continuance of *low*; it evidently is continually on the move, yet practically for some localities in the United States it is stationary for some two, three, and sometimes four days, and, on rare occasions, perhaps more; but the most severe spell of such a blow that I bear in mind is that which commenced on the first of March, 1872, and continued with unsurpassed fierceness till the fifth. During this time the conditions were evidently favorable for a concentrated and long *low* off the coast along down and by Hatteras, or, in what sailors call the "Devil's Corner." This was probably one of the most fierce and continuous winds that we have had along the Atlantic coast.

LXXXVI. Sometimes we see all, or nearly all, the evidences of a storm; the clouds form, the wind is in the right direction, and it "feels like rain," but no rain comes perhaps for a month, two months, or even more. Everything is parched for want of rain, and dust is very abundant. This has given rise to the saying "that all signs fail in dry times." It would seem that there could be no fault to find with the "signs;" so far as they are concerned they are all right—they are evidence of conditions actually existing, but the trouble is that these conditions are a long way off. *Low* circles around, but sometimes, more particularly in the summer, it goes very far in some one direction, the circles that it describes are very large while its own circle or center is apt to be contracted, so that it passes by some localities merely touching them with its outer edge, which frequently gives the "sign" as it passes, but nothing more; the rain that is developed, even in part, in the dry localities, is taken off to other places.

LXXXVII. Also on such occasions we see the evening flashes of light,

away off in the distant horizon. This, in order possibly to give a name even though the cause was not known, is called "heat-lightning." On the basis of these remarks, and I trust that they are not far out of the way, though we are still in the dark as to many facts, there does not seem as though there could be any such thing as is implied by this name, but rather that it is a *bona fide* lightning from some center of *low*—perhaps a *local low* or some regular passing centre of *low*, some twenty miles or more away.

LXXXVIII. There is also a common expression in regard to thunder, that "Thunder in the morning, sailors take warning; Thunder at night, sailors delight," as though it were a law that it was worse to have thunder in the morning than in the evening, etc. In the first place it depends upon which direction the thunder proceeds from; if to the East of us it is evident that the storm center or *low* has passed our locality; if to the North that it is passing; if to the South, that it is working its way up towards us; and if to the West, that we may expect it to be or come quite near us. Secondly, there may not be any great "delight" in hearing thunder at night, as in the other case, it all depends on the direction from which it comes, immediately about us, to the North, East, South or West of us. Thunder is more apt to occur in the evening on account of the development of the heat of the day (see section XXXVIII on electricity); where there is thunder in the morning it shows great heat and perhaps the development of a low barometer, and therefore indication of a severe storm. These remarks on thunder and lightning may also, in a general way, apply to the lines "a *rainbow* in the morning," etc. The principle is the same.

LXXXIX. Among other common notions in this department of the weather is the idea that at certain times, mostly morning and evening, when a few heavy broken clouds are massed together and the sunlight is shining through such openings as there may be here and there among them, that the sun is drawing water. This notion evidently grew out of the desire to account for a certain natural phenomena after a supposed reasonable manner; but the knowledge of the present will not sustain any such fanciful idea as this implies. In the first place the sun does not "draw" water, at least in the sense we commonly use this word. It *evaporates* the water and combines it with air, and thereby forms clouds. Secondly, this process is going on all the while, at least when there is sufficient heat. Thirdly, this phenomena called the "sun drawing water," is simply the rays of the sun shining through an opening, and we have the same effect whether the opening be in a cloud or in a wall. The denser the cloud immediately under the sun and the clearer the sky elsewhere, the stronger this effect will be.

In this paper it has been the aim of the writer, as may be readily seen, to bring together all the points in relation to the weather that he could think of, and in order to facilitate memory and to draw special attention to these points so that they would not be lost in the mass, he adopted the plan of numbering each item as it presented itself in as much order as possible, that one point might, as near as possible, suggest the other. He does not claim that he has discovered all, or that all his deductions are right. He has simply endeavored to present the subject

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from his point of view, and as the same appears to him. And now he stands like others interested in this beautiful study, awaiting further developments. Of course he would like to have future developments sustain what he has here set forth, yet he trusts that he will be enabled to see new facts in an impartial light, and if, perchance, more light should prove him in error as to conclusions, that nevertheless there may be found in this paper some points that may be of interest to those who seek to investigate the mysterious forces that go to make up our weather system. And he further hopes that the interest of the people at large will be general, and of so earnest a nature as to sustain the labors of those who are engaged in the duty of collecting facts pertaining to this branch of science, and extend to them a practical sympathy whereby they may be the better enabled to follow up the great work before them; and further, that this sympathy may so extend that the nations of the earth may enter into fellowship with each other in collecting facts that bear upon this subject; for only by such cosmopolitan measures can we hope to gain important facts from all quarters of the globe, whereby we may become familiar with the weather system or systems of the world. For this purpose we should have facilities to collect facts, not only from the civilized countries and places easy of access, but from such places as at present are quite inaccessible, either from peculiar conditions of people or climate.

PROGNOSTICATIONS.

After reading these *Statements and Comments* the reader may inquire if there is no way for the individual, unaided by instruments, to forecast the weather. There are certain signs which if one will note from time to time whereby they may become quite expert, but then these personal prognostications must necessarily be confined to the local conditions. The individual from his local standpoint cannot tell what the general conditions are; and herein is where the labors of the signal office particularly become of value, and of greater value than it is possible for the prognostications of the local observer to be, even to his own locality, for the general always governs the local, and knowledge of what is and has been, gives more value to the judgment of the future. A single individual standing on the ground cannot command a very wide horizon, and even on the house-top cannot command anything like the extended region of one who is up in a balloon two or three miles above the earth. The single individual, even aided by instruments, can only know of the conditions of his immediate vicinity; while the Signal Office from its daily reports is able to see the conditions of the whole country; it can note the rate, direction and intensity of the storm center, and from these form a very accurate calculation as to the probability of its passing along a certain line, and in influencing the weather at a particular locality; yet, notwithstanding this, almanac makers and others think they have, or pretend to have, some system different from the natural laws of calculation whereby they can tell what the weather will be a year in advance; and, to make their pretensions more absurd, they make no distinction between different localities, when it is a well-known fact, and now easily demonstrated, that two localities quite near each other may have, and often do have, quite different weather—one being hot

while the other is cold, one wet while the other is dry, all depending on the relative situation of *low*.

In the past, before we had the facts of the present, this ridiculous pretension was, perhaps, excusable, for then very little was known of the general weather system—we were all ignorant of the facts that have been ascertained within the past few years. The best that could be done was to judge the weather of one year by that of another, and really the whole matter of attempted prognostication, instead of being a thing of calculation was, and is, really, but a mere matter of guess-work. In these so-called calculations much was figured from the moon, when the moon is a most contemptibly insignificant force in the matter and has about as much to do with the matter as it has with making people mad. Yet, years ago, it was so firmly believed that the moon was the cause of madness that this satellite of the earth gave the name to that unfortunate affliction of humanity. No person now, however, will hold to the absurd idea that lunacy, even though the *name* is connected with the moon, is in any way caused by the moon. As explained elsewhere, the sun is the great physical force that makes our weather system. The better we understand all the forces that go to make up the weather system, make ourselves familiar with all the changes that occur in and constitute the conditions that follow one another, the better weather prophets we will become. We must necessarily keep in mind as much as possible the location of *low*, for on this hangs all the information we seek, remembering that the wind will always be *generally* towards the point of low barometer; by bearing this in mind we can approximate the location of *low* in relation to our locality. Then we must note the extent of cloudiness and familiarize ourselves with the different kinds of clouds, bearing in mind that the heavier the clouds and the more extensive the cloudiness the more apt we are to get rain. If the wind is to the east it shows that the centre of *low* is to our west and is approaching our locality, although the centre of the storm may go either to the north or south of us. The presence of low barometer is indicated by a closeness of the atmosphere, commonly called "muggy." If *low* is to the north of us we will have southerly and generally warm winds, while if to the south of us, it will be (relatively) cold (for the season); and, finally, to bear in mind the generally well-known fact that a storm clears off with a west wind and a clear, or quite clear, sky.

These points, noted and studied, will much enhance the correctness of our individual weather prophecies, though the individual can never, for reasons herein explained, rival the prognostications of the Weather Bureau, or foretell the weather for any length of time ahead; and it is doubtful if the Weather Bureau itself can ever foretell the weather for any great length of time in advance, but if it ever does it will only be after years of careful observations whereby it may discover certain changes (if such a thing exists) that take place at regular periods of time, but these changes are so unlimited and can be of such an endless variety it is very much to be doubted if they can ever be discovered to follow a regular course that may be calculated for any great period ahead. Yet, even though such appears to be a hopeless task, it should not hinder our labors in this direc-

tion nor cause us to neglect to follow up the good work so zealously begun, for we know not what high reward such earnest labors may meet with, and, even though we cannot discover any tangible law by which this is governed, there is still much left to acquire that will greatly repay us for our sacrifice in this behalf. If there be no similarity between certain periods we will still have gained a great point—we will have proved this as a fact and ascertained how this branch of nature works, for at present we are in the dark in this matter; yet, what facts we have tend to prove that the changes are endless and of infinite variety, and it would seem that the best purposes of nature were obtained from this system, for thereby the grateful showers are the most evenly distributed over the earth.

By the inauguration of the present Weather Bureau more knowledge has been gained in this department in a few years than was ever before known. The work of the past, however, is not to be depreciated, because the present has greater facilities. All enlightened people should be interested in these greater facilities, and, so far as they are able, lend a hand in advancing to them a greater degree of perfection. What we want now is coöperation on the part of the gatherers of scientific information the world over and then a combined and universal weather corps with facilities for extending its simultaneous labors over all important sections of the world, on sea as well as on land. It cannot be expected that so great a work as this would be accomplished in a few months, or even in a number of years, yet steps may be taken towards its accomplishment, and year by year we can advance our stations to new grounds and form combinations and awaken sympathy and zeal on the part of those who at present are ignorant or indifferent as to scientific matters. Only by such extended and united efforts can we fully understand the complete weather system of our planet, and it is to be hoped that the controlling spirits of the world will have sufficient interest and sympathy in the matter to arouse their zeal on behalf of so worthy a cause.

ISAAC P. NOYES.

WASHINGTON, D. C., April, 1878.

ON CLIMATIC CHANGES IN THE PRAIRIE REGION OF THE UNITED STATES.

THE EFFECT OF DISBOSCATION ON CLIMATE, AND THE RELATION OF FOREST GROWTH TO ATMOSPHERIC PHENOMENA.

BY COLONEL HENRY INMAN, OF KANSAS.

[*Continued from July Number.*]

It appears, however, to be unquestionably true, that the destruction of forests has within strictly historic times, wrought desolation in regions where the soil is inherently fertile and which once bloomed with all the splendor of a garden; districts that once were the scene of a busy population, and where mighty cities provoked the admiration of the civilized world, but which are now only howling

wildernesses through the agency of man; devastated by his own folly or his ignorance of nature's rigorous laws.

It is also unquestionably true, that a restoration, by the agency of man, to those regions their previous physical condition by the cultivation of forests, would re-establish their once boasted fertility.

The inquiry then is, if the destruction of forests would bring about the meteorological effects in certain districts—as will presently be shown—and their restoration reinstate the primitive conditions, whether a region primarily destitute of trees in consequence of climatic causes, with a soil as inherently fertile as any where on earth, but by deficiency of aqueous precipitation insusceptible to a fully developed system of agriculture, can be made by the artificial creation of forests to reach a state that will meet the complete requirements of our progressive civilization, agriculturally considered?

Reference will now be made to the most authentic statistics on the subject of the effect of disrobing a country of forests, after which will be shown what progress has been made in the cultivation of timber on the Great Plains, the possibilities in that direction, and how trees affect climate.

Mr. George P. Marsh, in his grand work* showing man's power over nature, and the influence he has exerted on the physical condition of the earth, says:

"If we compare the present physical condition of the countries [around the borders of the Mediterranean] with the description that ancient geographers and historians have given of their fertility and general capability of ministering to human uses, we shall find that more than half of their whole extent * * is either deserted by civilized men and surrendered to hopeless desolation, or at least greatly reduced both in productiveness and population. Vast forests have disappeared from mountain spurs and ridges; the vegetable earth, accumulated beneath the trees by the decay of leaves and fallen trunks, the soil of Alpine pastures which skirted and indented the woods, and the mould of the upland fields, are washed away; meadows once fertilized by irrigation are waste and unproductive because the cisterns and reservoirs that supplied the ancient canals are broken, or the springs that fed them dried up; rivers famous in history and in song have shrunk to humble brooklets; the willows that ornamented and protected the banks of the lesser water-courses are gone, and the rivers have ceased to exist as perennial currents, because the little water that finds its way into their old channels is evaporated by the droughts of summer, or absorbed by the parched earth before it reaches the lowlands; the beds of the brooks have widened into broad expanses of pebbles and gravel, over which, though in the hot season passed dryshod, in winter sea-like torrents thunder; the entrances of navigable streams are obstructed by sand-bars; and harbors, once marts of an extensive commerce, are shoaled by the deposits of the rivers at whose mouths they lie."

Spain was once famed for its fertility. In those days the forest covered immense areas; the hills and the valleys were dotted with emerald tinted groves,

*Man and Nature.

which to the Moors were as sacred as the oak to the Druids, and they were preserved with an almost religious zeal; but how different is Spain to-day?

Hardly a hundred years had elapsed after the expulsion of the Moors, before the Spaniards had stripped whole districts of their timber, and there followed deterioration of soil and aridity of climate to such a degree, that it may be considered one of the most important factors in the decay of her industries. Sir John F. W. Herschel in his work on physical geography, in discoursing upon the absence of trees in relation to the rain-fall, gives it this endorsement: "the destruction of the forests is no doubt one of the reasons of the extreme aridity of the interior of Spain. The hatred of a Spaniard toward a tree is proverbial."

In 1789, the valleys of the Rhone and the Gironde and the whole region of southern and southeastern France, the slopes of the Alps and the Pyrenees were perfect pictures of fertility. Immense herds of cattle and sheep were reveling in the rich mountain pastures, and the beautiful valleys that nestled between the lofty ranges were as fruitful as a summer garden. The soil was rich in all the elements of productiveness, and the climate as delicious as under the Italian skies.

At that time the vast forest of Cévennes bordered the Rhone, and the mountain slopes were densely covered with a growth of giant timber, all of which have gradually disappeared under the ruthless axe of the woodman, bringing with the work of devastation climatic results that have completely changed the scene of beauty into one of desolation.

The whole region now is visited by intense drouths, deluging storms, and fearful cold in turns. Torrents of maddened water have plowed through the once purple vineyards, and huge masses of rock, extensive reaches of sand and beds of gravel have filled up those once charming valleys and converted them into irredeemable wastes.

These changes of climate in France, due to the disboscation of the forests, have been so marked that the government revenues from the districts referred to have been reduced to almost nothing in comparison to what they were a century ago. Hon. G. P. Marsh* again, in referring to this same subject, says:

"There are parts of Asia Minor, of Northern Africa, of Greece, and even of Alpine Europe, where the operation of causes set in action by man has brought the face of the earth to a desolation almost as complete as that of the moon; and though, within that brief space of time men call the "historical period," they are known to have been covered with luxuriant woods, verdant pastures and fertile meadows, they are now too far deteriorated to be reclaimed by man; nor can they become again fitted for human use except through great geologic changes or other mysterious influences or agencies of which we have no present knowledge, and over which we have no prospective control."

The author of "Economie Rurale" furnishes an account "of the subsidence and subsequent increase of the waters of Lake Valencia in the valley of Aragua. Prior to the visit of Humboldt in 1800, the volume of water had been diminishing for half a century, exposing from time to time the surface of numerous islands

* Man and Nature, 1864.

entirely covered by water at an earlier period. The distinguished traveler made the phenomena a subject of careful examination, proved the unsoundness of the usually received hypothesis of a subterranean outlet, and did not hesitate to explain the gradual depression of the level of the lake as the result of the numerous clearings made in the valley during the latter half of the preceding century.

"In 1822 Boussingault visited the locality and found that instead of retiring, the waters of the lake had been sensibly rising for several years. A number of sugar and cotton plantations on land formerly constituting a part of its bed had become submerged, and the islands above the surface at the time of Humboldt's visit had disappeared. No apparent reason existed for this, as no particular change in the seasons had been noticed. Boussingault proceeds to state that during the war for independence by the South American colonies, the fertile valley of Aragua became the theater of bloody struggles, desolating its fields and exterminating its population. The large plantations, which during the preceding fifty years had been wrested from the domain of the forests were abandoned, and in the tropical climate of Venezuela the ten or a dozen years that had elapsed had been sufficient to cover them a second time with trees and shade; the rise of the water of the lake keeping pace with the encroachment of the forest. Other instances are mentioned by the same writer of large clearings in Venezuela and New Grenada being accompanied by a similar disappearance of the waters of adjacent lakes, while in districts always bare of trees, or where the forest had never been disturbed, no such changes had occurred. This eminent scholar maintained that the lakes of Switzerland have sustained a like depression of level since the too prevalent destruction of woods and arrives at the general conclusion that 'in countries where great clearings have been made there has most probably been a diminution of the living waters which flow upon the surface of the ground, and that very restricted local clearings may diminish and even suppress springs and brooks without any reduction in the total quantity of the rain.'

Marchand relates the circumstance of the Lorne and the Doubs, streams in Switzerland, from time immemorial furnishing an abundant water power for the manufacturing establishments on their banks, becoming so deficient in the supply of water after cutting the woods near their sources, as no longer to furnish the required power, so that in one case steam had to be introduced and in the other the factory was stopped entirely.

Hummel mentions a striking instance of the influence of forests on the flow of springs, as witnessed at Heilbroun. The woods on the hills surrounding the town are treated, it appears, as a copse, being used only for supplying fuel. They are cut at intervals of twenty or thirty years, and planted or allowed to shoot up again from the roots. Regularly after each cutting the springs of Heilbroun fail. But as the young shoots increase in size, the water flows more freely, and at length bubbles up again in all its original abundance until the next cutting takes place.

But the conservative influence of trees is not confined to mountainous and warm countries. The climate of the Schelde Valley and the plains of Bavaria and of Austria was so much injured by immoderate clearings, in the judgment of

those having the best opportunities of deciding correctly, that extensive areas have been replanted, with favorable effects, it is said, anticipated by the projectors of the enterprise."

The Imperial Academy of Vienna in 1073, appointed a special committee composed of distinguished savans, members of the constitution, to discuss and report upon a memoir presented previously by Mr. Hofruther Wex "upon the diminution of the water of rivers and streams." These sessions were held by the committee and the memoir of Mr. Wex exhaustively argued. An immense mass of statistics were presented and the report of the commission, elaborate in details, sums up its opinions as follows, for which only we have room: "The fact of the diminution of water in streams, which diminution is connected with the copiousness of springs which supply them, being admitted, the commission find the causes of this phenomenon: 1st. In the continued cutting down of the woods whose salutary influence in the raising of the hygrometer, the amelioration of external temperature, the decrease of evaporation, and the promotion of a regular escape of the precipitation is evident. 2d. In the desiccation of the lakes, ponds and bogs, which likewise raises the hygrometic conditions, decreases evaporation, moderates extreme temperatures, and lastly, through the fissures in the soil, directly promotes the formation of springs." * * *

It has been abundantly shown in the foregoing references, that the desiccation of lakes and bogs, which the Vienna Academy, in the report of its commission, assigns for the second cause for the "diminution of water in rivers and springs," is directly attributable to the extinguishment of the forest; consequently the causes which the commission finds, to account for the phenomena under their consideration, may be stated fully in their first conclusion. In other words, the conditions for which they were to assign a cause, is found in the disboscation of the timber of the affected region.

The devastating and disastrous climatic results of disrobing a country of its wealth of timber, have been so incontestibly proved by the distinguished authorities quoted, that it leaves very little room to doubt the correctness of the conclusions arrived at, and they are consequently divested of any hypothetical aspect.

In order fully to comprehend the relations of forests to climate, it is necessary to devote a little space to the nature of vegetation, and the process by which vegetable life is sustained.

Nearly all the inorganic matter essential to the perfect development of plant life is extracted by the secret operations of nature from the soil surrounding their roots, while the sugar, acids and starch are derived from the air.

The rainfall is the agent by which inorganic substances are so disposed that the roots are enabled to select and assimilate that portion which is essential to the life of the plant.

Carbonic acid, a substance as necessary to the support of vegetation as atmospheric air to animal life, is constantly absorbed by day, by the leaves of plants, the carbon of which is separated by them and metamorphosed into woody fibre; the oxygen, the other element of the compound, being rejected, is

returned to the atmosphere. Ammonia, another important constituent in the life of a plant, results from the decay of animal matter, and is taken up by the atmosphere, from whence it is returned to the soil in the rain and snow, it is then absorbed by the earth and taken up by the plant, which separates it into its elements, one moiety of which enters into the formation of the wood and the other into the gluten.

Humus, or black mould, the evidence of fertility in soils, is decayed vegetable matter; when the earth is plowed up the underlying humus is brought in contact with the air and a fresh supply of carbonic acid is supplied. Humus is the source of vegetable production in every soil, and the impoverishment of land is principally owing to the removal of the annual product without the return of an equivalent. Where the vegetable matter is allowed to decay on the soil, its richness is constantly increased, and the result, for long periods, is the mighty fertility of the virgin lands of the great West.

There is hardly any portion of the great Plains where the soil is not sufficiently rich to meet all the requirements of vegetable life in a remarkable degree; the accumulation of humus by the early decay of the luxuriant grasses that have carpeted them for centuries has given them a soil of the highest agricultural possibilities.

Lime, in some of its combinations, constitutes as an essential engredient in all the more valuable cereals, both grain and grasses. Its presence in the soil is consequently to be considered as a condition of fertility. It has a powerful tendency to augment the consolidation and tenacity of land, and its power of retaining water. It also promotes the putrefaction and decomposition of humus, and the reciprocal action of the fluids or nutritive juices contained in the soil, and imparts its carbonic acid to the humus, or even to the plant itself.

The hull or epidermis enveloping the farinaceous portions of grain grown on soil in which there is a due admixture of calcareous matter, and the farina itself is much greater in quantity and richer in quality than in grain grown on lands which exhibit a deficiency of this earth.

The excellent quality of the wheat grown to day on the far western prairies, beyond the Missouri, in Texas, Kansas and Nebraska, is due to the fact that over those regions there extends great limestone zones, destined to be the most important wheat fields of the continent, which experience is demonstrating yearly, as each season the "golden belt" is pushed farther westward.

The civilization and subjection of the "Great American Plains" to the uses of man, is not then a question of inherent fertility of soil, but of aridity of climate, and possibility of ameliorating changes through his agency, in the creation of forests, and improved systems of irrigation, upon which depends the solution of the question.

The effects of forests upon climate are manifold, and in those countries from which they have been ruthlessly torn by the ignorance of man we may read a lesson how climate is modified by their presence, and how the vast interior area of the United States, if it can be clothed with arborescent forms, will be metamorphosed into the best agricultural region of the continent.

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The presence of forests shelter the earth's surface, through the agency of their dense foliage, from the scorching heat of the sun. It has been conclusively shown how they act as a source of the perpetual supply of springs. They break the force of the wind in an astonishing degree, and are the direct medium in the retention of moisture over areas within their influence.

Becquerel states: "That in the valley of the Rhone, a single hedge two metres (a little more than five and a half feet) in height, is sufficient protection for a distance of twenty-two metres (seventy-two feet) in length."

On the prairies of Texas, Kansas and Nebraska, a narrow belt of Osage orange, or a double row of cottonwood or peach trees, as is well known in the experience of the inhabitants of those localities, is an effectual barrier against the high spring winds of the plains for comparatively extended distances, and the effects of this wind-break are felt at a considerable elevation above the height of the trees or shrubs which compose it.

These wind-breaks, as they are called on the plains, protect equally from the not infrequent furious storms of winter, and the occasional hot winds of summer. In winter, too, the snow is piled up in great drifts, parallel to the hedge or row of trees, and thus deposited, prevent the frost for some distance from bursting the ground open; in the spring the snow melts slowly away and soaks the earth thoroughly; instead of immense creeks, occasioned by the action of the frost, as in exposed situations, swallowing the rains of that season without doing a particle of benefit, the precipitated moisture is evenly distributed, and the earth in a condition to retain it. In summer, the air in the immediate region of these timber belts is cool, and the soil in the vicinity retains its moisture for a long time relatively.

Marsh* says, in regard to the effect of trees as a barrier to the wind: "* * there is no doubt that the effect of cold blasts can be greatly mitigated, and observation shows, that while the tops of the trees are swayed by their violence, the surface will be found calm and warm. * *"

The constant presence of moisture in forests will be admitted by the most careless observer who has ever lived in a timbered country. This moisture, as a matter of course, must be constantly evaporating, and consequently modifies the heat of the surrounding region. The compact foliage of the forest condenses the moisture from the passing breezes, and refreshing showers on the contiguous country is the result; were it not for this mass of cooler matter thus presented to the actions of the winds in their transit over the region, there would be no condensation, or at least but little, of their aqueous vapor; in a district, therefore, destitute of timber, though the currents which sweep over it be fairly freighted with moisture, they part with but little of it, and that portion of a continent would fall under the odium of a "barren waste." This appears to have been the condition of a large portion of the prairie area beyond the ninety-eighth meridian primarily, but which is changing, and rapidly succumbing to the influence of civilization; every tree, every shrub planted, every acre that is turned

*Man and Nature.

over to the sun, performs its part in the wonderful metamorphosis that is taking place.

The roots of trees penetrate deeply into the reserve of moisture below the surface of the earth, and constantly draw by capillary attraction a portion of it which is exuded by the leaves, and the humidity of the air increases, as explained above, and the temperature lowered.

Shacht says: "In wooded countries the atmosphere is generally humid, and rain and dew fertilize the soil. As the lightning-rod abstracts the electric fluid from a stormy sky, so the forest abstracts to itself the rain from the clouds, which in falling refreshes, not it alone, but extends its benefits to the neighboring fields. * * The forest, presenting a considerable surface for evaporation, gives to its own soil and to all the adjacent soil, an abundant and enlivening dew There falls, it is true, less dew on a tall and thick wood than on the surrounding meadows, which being more highly heated during the day by the difference of insulation, cool with greater rapidity by radiation. But it must be remarked, that this increased deposition of dew on the neighboring fields is partly due to the forests themselves; for the dew saturated strata of air which hover over the woods, descend in cool, calm evenings, like clouds, to the valley, and in the morning beads of dew sparkle on the leaves of the grass and the flowers of the fields. Forests, in a word, exert in the interior of continents an influence like that of the sea on the climate of islands and of coasts; both water the soil, and thereby insure its fertility."

This phenomenon of the condensation of dew is witnessed to-day on the prairies beyond the Missouri as far as civilization has reached, and it appears to be the result of causes analagous to those ascribed to the presence of forests; large areas of corn and immense fields of the other cereals, presenting the same conditions, in a reduced ratio, however, as belts of woods; at any rate, lands where ten years ago the presence of dew could not be detected, now receive this blessing in full measure, showing that the changes produced in the nature of the vegetation by the progress of civilization, the cultivation of forms superior to the low grasses of the region in its primitiveness, are sufficient in increased surface presented for evaporation to condense that which is thus extracted in the form of dew, and thus save for the fertilization of the soil that which was once carried off by the atmosphere for the support of other regions.

The absolutely cloudless skies, nights which knew not the refreshing indraught of the beaded dew, the wonderful pictures of the mirage, and the stifling heat of the noon-day sun, were the peculiar characteristics of the climate of the plains, as narrated in the reports of the early explorers, and to-day, in a certain degree, these are the distinguishing features of a large portion of the interior of the continent. But great changes have been wrought by the presence of man, and his power to subordinate nature to his use is so mighty that even the elements seem to bow to his imperial will.

The railroad was the potent *avant courier* of the wonderful civilization which was so soon to follow in its wake, and although at first the hardy pioneer stepped

hesitatingly within the mysterious domain spreading out almost illimitably before him, he found that his prospective desert only needed the magic touch of the genius of agriculture to convert it into a garden; and so the hundreds of thousands who have followed his footsteps here on the "iron trail," and with the speed of the wind, are helping to build up that vast empire which is the destiny of that portion of our country.

"The plow has invaded the plains and has conquered," says my eloquent friend Col. Elliott. At intervals for six hundred miles beyond the Missouri, thriving villages have sprung up whose metropolitan aspect and rapid growth are marvels of the nineteenth century. Around these centers of civilization, and far beyond the ninety-eighth meridian too, under the munificent laws governing the disposition of the public domain, the whole territory is rapidly being converted into an agricultural region which promises the grandest results. Wherever the rich sod of these magnificent natural fields is brought under the empire of the plow, nearly every variety of vegetation which characterizes the primitive prairie retreats like the original owners of the soil before the conquering tread of the white man.

Nature has furnished in these far-stretching plains almost every variety of soil, but with a characteristic inherent fertility whose productiveness approaches, under a true system of agriculture, the marvellous.

Nowhere on the American continent does the opportunity for a diversified agriculture present itself as on the prairies of the far-west. All the cereals can be successfully grown on the rich bottom lands, or on the equally fertile elevated divides which separate the valleys.

Altitude above the sea level seems to enter largely into the problem of fruit culture, and the possibilities in this direction are only limited to varieties as we approach the more lofty plateaus westward.

That the forest may be extended over the major portions of the great plains in areas sufficiently large to effect the climatic changes which their presence induces, is believed not only possible, but probable, if we can predicate from the progress already made in this particular. Where the sun for centuries has poured down his rays upon the carpet of short grass, or upon the brown and rusty earth; where the rustling of leaves in the spring time is never heard, and where the solitary smoke of the red man's wigwam oftentimes constituted the only cloud in the whole expanse of the clear blue sky—man in his "hunger for the horizon," as Senator Ingalls, of this State, so eloquently expressed the march of the hardy yeomen of the Eastern slope who are pressing upon the foot-steps of the receding savage, will find the land now "full of harvests and green meadows," either through the agency his presence exerts in changing the climate, or by a system of irrigation his genius commands.

Two-thirds of the length of the Great Plains, east and west, from far north of the Platte, to their extreme southern border in Texas, is already productive, as a tour through that region or reference to authentic statistics will confirm. I have argued in the affirmative for the districts away to the mountain slopes which

are now only covered with grass, that in its entirety it is not condemned for all time to a mere pasturage. The plains are not sterile as was and is believed by many to-day. Their proportion of unproductive land in consequence of inaccessible bluffs or rocky mesas is less than in any other equal area on the globe. Portions of the far-off plains are only comparatively arid; with precipitated moisture in sufficient measure—which will in time come—or water through the medium of irrigation, the richest agricultural results are assured. That the whole of the vast interior area of the continent will become habitable as rapidly as the demands of civilization require, we should have no doubt. When the limit of sufficient precipitated moisture is reached, or where the timber will not grow spontaneously—for that will be the line of demarcation—but which has not yet been determined—then the available streams and rivers of the region must be used for irrigation.

The remarkable excess in inches of the spring and summer rains over those of autumn and winter, and which have persistently increased in measure as civilization pushes towards the mountains, have permitted thousands of farms to be opened far beyond the ninety-eighth meridian, whose productiveness in corn, wheat and other cereals have astonished the world, justifies the assertion that the limit where a sufficiency of aqueous precipitation ceases, and irrigation must be depended upon, is not yet reached. Whether that will be attained until the actual slopes of the mountains are compressed, as is confidently believed by some, cannot yet be determined. The writer does not accept that theory fully, on account of apparently dominant adversely controlling forces in the immediate locality of lofty ranges, though he does not deny the possibility of the truth of the theory.

At the foot of the mountain slopes the streams have already been utilized for the purpose of irrigation most successfully, flowing as they do in so many pleasant lines from the rainy and snowy heights of the Rocky range, and this system of cultivation will spread eastward to meet the progress of civilization that is rapidly moving westward until the lines of sufficient precipitation meet those of irrigation, and the hiatus now existing between the advancing armies of permanent occupation is closed.

To many who have not studied the changes that are taking place on the great plains, it probably seems a curious and presumptive proposition that they are destined to become the principal food-producing regions of the Continent—perhaps, of the world—but the idea will not appear so unwarrantable when we reflect how rapidly their agricultural proclivities are being developed and that the theories of the laboratory and the speculations of the professor's study in relation to them are sadly in opposition to the truth; facts are answering the problems of that region with more effect than philosophy.

It makes no difference in the solution of the proposition, that the whole interior portion of the United States under consideration will be made habitable, whether the necessary changes which are to effect the result are slow or rapid; it is an established fact, however, that as civilization reaches out into the wilderness

with confident tread there is no retrograde march; it is ever onward, life is sustained and communities spring up and prosper.

On the broad prairies beyond the Missouri, water is found in abundance, either in rivers, streams, springs, spring-fed pools, or can be obtained by digging wells at inconsiderable depths. In the important relations of this article, therefore, to human economy, the people of those regions need entertain no doubts on the subject of a sufficient supply. This is an important consideration in discussing the possibilities of forest culture, and upon this fact and the power of the soil of the plains to retain moisture, coupled with the supply beneath the surface, into which the roots of the trees will send their delicate tubes and receive their nourishment in part, is predicated the sneers met with already, and the assurance of further operations in this direction. It is not an improbable theory that beneath the area of the great plains there are considerable streams flowing eastward, at intervals, over their whole breadth, which, under certain aspects, serve in the economy of the moisture of those regions. This was a favorite theme of the late Professor J. W. Foster, LL. D., of Chicago.* I do not know whether it was ever promulgated by him in any of his works, or only conceived after he became too ill to write, but I recall a conversation with him, a short time before his death, on the subject of the source of supply of the Great Lakes, in which he thought that a possible answer might be found in subterranean streams whose reservoirs were the excess of the precipitation in the mountain ranges of the far West over the amount of the evaporation and that carried away by the visible conduits of the region.

As two confirmatory proofs of the plausibility of subterranean streams flowing far to the east of the mountains, I offer the following facts, the first of which came under my own observation, the second under that of a scientific friend: Upon a high "divide" between the Smoky Hill and Saline rivers, in Western Kansas, on the northern edge of the water-sheds of the cañons of the Saline, the Kansas Pacific railway company bored for water some years since, unsuccessfully, after attaining a considerable depth; this was in the fall. An examination of the physical formation of the immediate locality partially explains the reason why they failed to reach the veins running at the usual distance, thirty to sixty feet. The bore was located upon the extreme limit of an inclined plane sloping south to the Smoky Hill. On the northern rim of this plane the Saline has cut its channel more than three hundred feet below the level of the well's mouth; on the south the Smoky Hill flows over two hundred feet below at the foot of the slope, seven miles away. The water courses of that district, both above and below the surface flow to the south into the Smoky Hill, and not, as would superficially appear most natural, into the Saline. Underneath the surface, at an average depth of thirty feet, lies the shale, above which, but never in, all the water of the wells is found. To the west and to the east the plane is cut down to the shale beds by streams and cañons which deprive this plane of its supply of water

*President of the American Association for the Advancement of Science, Lecturer on Physical Geography, Author of the Mississippi Valley, &c.

except by the infiltration of precipitated moisture, but there is not sufficient area to furnish this well on the theory of infiltration of rain. At the time of the spring freshets, caused by the melting of the snow in the mountains, this well overflows, and when the period of the freshets has passed and the streams in that region assume their normal level, the water of the well subsides until the next season of freshets when the same phenomenon is presented, and thus keeps up its intermittent character. The other phenomenon was witnessed by a friend, as stated, in Chicago. In building one of the light-houses on the shore of Lake Michigan, near that city, it became necessary to make the foundation of piles, and, after the circular group had been placed in position and an attempt was made to drive the last and center pile, it apparently broke through a crust or shell and disappeared. A cord and plummet was sunk through the opening and a swift running stream was discovered flowing into the lake.

The writer's experience on the plains, west of the ninety-eighth meridian, ten years ago, seemed to warrant the assertion, even then, that there was a larger amount of humidity in the atmosphere of that region than a superficial observation would concede. Clouds formed every day, and in the summer, the most decided indications of showers would present themselves, but would pass off without precipitating their refreshing drops on the earnest earth, this phenomenon proved sufficient moisture, but the conditions necessary to force precipitation were absent. With the introduction of the plow, and the cultivation of crops and forest plantations, a wonderful change has taken place; now it is the rule, where before it was the exception, for the clouds to precipitate their moisture, and showers are frequent; then a storm could be seen forming, and "the rain, like a curtain," suspended in mid-air, but rarely reaching the earth, re-vaporization apparently arresting the shower on its course to the ground; now this curious meteorological scene is rarely witnessed in the settled area, and disappears as civilization moves onward.

The fact must not be overlooked that the mere breaking up of large areas by the plow in the prairie region has been an effective agent in the phenomena of climatic changes. The moisture, instead of being rapidly drained into the ravines and water-courses, has sunk into the soil and furnished nourishment for the new vegetation which shades the ground more perfectly than the grasses and presents a larger surface for the condensation of the atmospheric humidity in the form of dew. The reflection of heat has been modified and the floating moisture has been attracted to the earth in the same manner as the electrical fluid is drawn to a good conductor. When we consider how many square miles of territory are each year turned over, we cannot but admit the truth of the belief that the disturbance of the soil enters largely as a factor in the problem of ameliorating causes.

Extensive tree growth on the plains has unquestionably sensibly affected the climate and brought about the varied phenomena attributed to the presence of forests, and the argument of the possibilities of success in clothing the grassy

prairies beyond the Missouri with arborescent forms depends only upon a proper system of culture, and a true conception of its importance.

The results of timber growth on the prairies of the far-west, and into the "desert" of the early writers, is something astonishing. Want of space precludes the idea originally intended of tabulating what the writer has observed, but a visit to those regions will disclose to the most casual looker on a remarkable picture of incipient forest to-day, either on the bottoms or on the uplands of any locality where civilization has established itself.

These groves of puny timber, far beyond the ninety-eighth meridian, have in some sections already given, to the traveler passing through, the appearance of a wooded country. More than three hundred miles beyond the Missouri, in Kansas, at an altitude of over two thousand feet above the sea level, the young tree plantations of cottonwood have made in two years a growth of from eight to twelve feet; the box-elder from three to six, and the white ash about two feet. All of these varieties are indigenous, and are found fringing the streams, from which localities the seeds are gathered and the slips cut. Apples and peaches have been raised successfully for some years on and beyond the ninety-eighth meridian, and, still farther west, cherries and peaches in the new settlements have come into bearing. The wild plum which grows in profusion far beyond the ninety-eighth meridian, rivals its domestic brother of the old orchards of the east; so much so that some which the writer had forwarded for exhibition at the Centennial, in the Kansas display, were pronounced by Hon. A. Gray, Secretary of the State Board, superior to the cultivated species.

The prairie soil seems to possess a wonderful inherent power in the development of root-growth. In 1866 or 1867, the students of the Commercial College at Topeka, established a short line of telegraph for the purpose of instruction, and used as one of the poles a green cottonwood six or seven inches in diameter, sawed square at both ends, and denuded of its limbs. This log—for it could not be called anything else—was set up on the main street, on the high ridge on which the town is built, and far from any water-course. It took root, and to-day is a magnificent tree twenty inches in diameter, with huge, overspreading branches, and taller than the fine buildings in the vicinity; in fact, I am told that the limbs have been cut back repeatedly, so rapid has been its growth.

A favorite method of commencing forest plantations in many portions of the prairie region beyond the Missouri, is to plow under green saplings deprived of their limbs and notched at intervals, from which a shoot appears above the ground and takes root as the parent stem decays.

The rapidity with which forests can be made to reach proportions that will have a visible effect on the climate of a region, is remarkable, and the relatively short period required to bring about these conditions on the plains, has been one of the greatest incentives to forest growth on the prairies of the far-west. Time, then, does not enter so largely into the problem as one would at first imagine, and this fact is being duly appreciated by the pioneer civilization of the country beyond the Missouri.

Prof. Hayden,* in his geological survey of Nebraska, "examined young cottonwoods ten years old from the seed, measuring fifty feet in height, and four feet in circumference; others of the same age, two feet, eleven inches in circumference, and thirty feet high; at eight years old, two feet, eight inches in circumference; at four years old, eighteen inches in circumference and twenty feet high; and at seven years old, two feet, one inch in circumference, and fifteen feet high. Soft maple of ten years growth, two feet, eight inches in circumference, and thirty feet heigh; at seven years old, two feet, one inch in circumference, and fifteen feet high. Common locust of ten years growth, two feet, five inches in circumference, and fifteen to twenty feet high; five years from seed, twenty-three inches in circumference. Black walnut, ten years from seed, thirteen inches in circumference and fifteen feet high. Box elder ten years old, two feet, two inches in circumference. Equally good results have been obtained in Kansas, and in the valley of Salt Lake where irrigation is practised. * *"

The writer recalls to memory one grove beyond the ninety-eighth meridian which during the last ten years has been cut down and grew up, at least three times, and the material hauled off for fire-wood, the trees at each cutting having attained a heighth of from five to twelve feet. If this belt had been permitted to remain unmolested, it would have been by this time a dense woods.

It seems to be possible, that under the proper conditions of culture, these young forests may be extended to the foot of the mountains, as the single trees, hedges and groves first planted by the settler, in connection with his extensive disturbance of the soil, bring about such changes, that as the conquest of the prairie is advanced, the forest belt is pushed out with it. The first tentative attempts at hedges and little door-yard clumps, acquire the power of retaining, not only the local humidity, but of attracting and precipitating that which the winds bear, which, without the presence of the trees, would have passed over the region as dry winds. Deluging storms occur less frequently, and the rain does not run off the cultivated surface, as rapidly as when the comparatively hard and baked earth alone was presented to the shower. Evaporation from the earth directly, as well as through the medium of the vegetation, takes place throughout the seasons, and where once, too, the sun shone through an atmosphere apparently devoid of sufficient humidity even for the condensation of dew.

Horace Greely wrote in the *Tribune*, on one occasion after a trip on the "Great American Plains:" "I have a firm faith that all the great deserts of the Temperate and Torrid zones will yet be reclaimed by irrigation and tree planting."

It will be conceded that the possibilities of forest growth on the Great Plains, as has been hurriedly shown, are not inconsistent with the view presented in this paper on the "Origin of Prairies;" that they are due to insufficient precipitated moisture, which is undoubtedly the cause of their treelessness, not, however, for the reason that the absolute precipitation is not enough to sustain tree growth when once inaugurated and guarded by conditions, for on at least a larger portion

*Report of the Secretary of the Interior, 1868.

of the whole interior prairie area, and far beyond the hundredth meridian, too, but because it is not sufficient in measure to protect the young shoots from destruction by fire; far east of the ninety-eighth meridian, and far west of it too, it is the universal rule where the annual fires are stopped tree growth soon begins, and to-day extensive groves can be seen remote from water courses, that have thus spontaneously sprung up as it were.

Far beyond there is a region, however, where, as observed previously, the annual fires do not affect the question of the encroachment of the timber on the prairie, contiguous to the streams to which it is rigidly confined; but even there, as civilization pushes forward, such ameliorating changes occur, and forest plantations thrive so flourishingly, as apparently to stultify all previously conceived theories.

The increase in the volume and persistency of streams on the prairies, is a fact vouched for by the experience and observations of thousands who live in the region beyond the Missouri, and that this phenomenon is directly attributable to the civilizing influences at work in the cultivation of timber, the disturbance of the soil, and other allied energies of frontier settlement, must be conceded with all the precedents of history before us. My own observations on the plains, west of the ninety-eighth meridian, during an almost continuous residence of twelve years, in which time the settlements have pushed forward, and large agricultural districts been opened up on the so called desert, confirm the assertion that the volume of water in the streams has perceptibly increased. Small tributaries to the principal rivers, whose sources are springs which flowed formerly only periodically, have become constant, and the beds through which the water found its passage at certain seasons—the remainder of the year being absolutely dry—now maintain a continuous current Depressions in the prairie at the foot of inconsiderable bluffs, which in the spring alone contained water (called water holes by stockmen), but which in the early summer became dry, are now permanent pools with a spring-like energy. Hon. Jacob Stotler, editor of the *Emporia News*, who has resided in that portion of Kansas for twenty-one years, informs me that the "Cottonwood" before and up to 1857–8, "could be crossed on the riffles dry-shod anywhere." Since that time, he says, and with the settlement of the country, the volume of water has increased yearly, and from that date he does not remember, at its driest stage, for any time during the last ten years that there has been less than eight or twelve inches of water in the shallowest places. Mr. Stotler also called my attention to a grist mill established on that stream many years ago, that frequently had to stop in consequence of the scarcity of water, but for the past decade, notwithstanding an increased demand upon the power, has experienced no difficulty in that particular, never since having been compelled to suspend from that cause.

In discussing the agricultural possibilities of the Great Plains, Rev. J. A. Anderson, of the Manhattan college, argues thus: "When a man harvests twenty bushels of wheat to the acre, that fact is quite as satisfactory to him as any analysis of the soil, or any record of the rain-gauge. And if through a

period of years, this fact repeats itself as often as in those states where an experience of generations has demonstrated their adaptation to wheat raising, he would disbelieve any assertion not in unison with the facts. On the one hand, he would be slow to expect that his field could average seventy bushels to the acre; on the other hand, he would laugh at the statement that the soil was too poor, or the supply of rain too small for profitable wheat growing. However valuable the facts and theories of the general science relating to agriculture may be, and many of them are valuable, still the best of all possible evidence to any practical man is the bins and the ledgers." With just such logic, and faith in the kind of prayer that taking hold of the plow-handles believes in the immutability of nature's laws, are people filling up the prairies of Texas, Kansas, Nebraska, Colorado, Dakota, Wyoming and Montana, satisfied with, and proving better than any theory worked out in the studies of the scientists, that the Great Plains are intended for the habitation of man, but to be wrought out by his immortal genius, through which he will yet see grand states grow up among the rocky peaks, and in the interior of the continent hitherto considered a desert and a waste.

We must be convinced in face of the facts presented that the climate west of the Missouri has changed, and that this change coincides with the advance of civilization into the interior prairie region. It is certain that the rain-fall has increased, and if the influences are correctly assigned, the ameliorating modifications will be progressive over the whole central area. Each season witnesses a larger portion of the whole domain subjected to the demands of the inrushing immigration, and greater encroachments of the forest growth. In Texas, Kansas, Colorado, Nebraska, Wyoming, Dakota, Montana and Utah, these modifying influences are extending, and it is no wild flight of the imagination to predict such corrective changes as are witnessed to-day over portions of the interior of the continent, for the entire prairie region, and the results obtained justifies the belief that the creation of forests through the agency of man in a district primarily devoid of trees, will bring about conditions the opposite of those which a like agency in other countries has effected by destroying them.

Illinois, Iowa, Minnesota and portions of Ohio, are confirmatory proof of the argument that civilization ameliorates climate. Increased growth of timber in those states has resulted in greater regulating and more equable distribution in the rain-fall. In the early settlement of Iowa, twenty-five years ago, that state was the theater of destructive inundations, excessive drouths, and sudden changes of temperature; all these phenomena have disappeared in a remarkable degree. Eastern Kansas, Nebraska, Colorado, in the vicinity of Denver, Eastern Texas and the great Salt Lake Valley; in short, in all localities of the "Western Wilds" where civilization has established itself, nature has evinced her readiness to second man in his efforts to subdue the primitive region to his uses; and the changes the above mentioned districts have experienced, the region in the Central Plains is experiencing, although it is only ten years since the immigrant wandered into their confines.

The indigenous trees of the plains west of the ninety-eighth meridian, are

not limited to a few species, but exhibit all the varieties necessary to meet the requirements of the vast civilization that is gradually investing that region, and the difficult experiment of transplanting exotics to maintain forest growths is not an obstacle to the possibilities of timber culture. The immigrant has only to avail himself of the seeds, or young shoots, which he finds at his hands, to commence his tree plantation; and it is perhaps to this fact that such a large area is already devoted to timber.

European nations have awakened to the importance of the preservation of existing forests and the creation of new forests as an agency in the amelioration of climate, and rigid laws have been enacted and are in operation to-day in France, Germany and Russia. Not only are these laws applicable to the public domain in those countries, but their effect reaches the estates of individuals, so thoroughly alive to the relations which forests maintain to climate are the authorities.

Institutions devoted entirely to scientific forest culture have been established at more than a dozen places in Germany, and in France over four thousand salaried officers are attached to the "Bureau Central de'l Administration General des Forêts." In these institutions the professors are persons of the highest scholarship. Lectures are regularly delivered on all the coördinate branches of forest culture: the principles of forests, measurement of forests, forest nursery, vegetable physiology, forest botany, forest microscopy, forest zoölogy and entomology; in short everything which relates to the subject in its minutest details. In France the "Gardès Genevare" number nearly five thousand, who perform the work of the public forests under the direction of the central office in Paris.

The Russian government has attempted the difficult problem of extending forest growth over the steppes, a region of drifty sands, and has met with perfect success, as the many thriving forests of timber reported in existence there attest.

The majority of the planted forests of Europe are in a region whose soil is infinitely inferior to that of the poorest of the western plains. In the sandy tracts of Northern Germany, "from Berlin to the Baltic and the German Ocean, including the Prussian provinces of East and West Prussia, Pomerania, Mecklenburg-Schwerin and Mark Brandenburg and the kingdom of Hanover, are in many places covered with deep sand, lying upon the surface so loose as to be moved about by the action of the wind like the billows of the sea." In this really desert-aspect region are found the finest artificial forests in the world.

In France, on the western coast, are immense sand hills, sometimes attaining a height of three hundred feet, and here, as well as on the sand dunes of Gascony, dense forests have been planted, which stand in a soil of pure sand, but which are growing luxuriantly, and are reclaiming a region which had always heretofore been regarded as hopelessly sterile.

One authority says: "The dune lands and sand plains of that country, estimated as equal to about twice the area of Maryland, or as covering more than thirteen million acres, most of them naturally as arid as the Llano Estacado of Northwestern Texas, are being everywhere brought under cultivation by planting them with pine."

Geology proves that the Russian steppes, like our own great plains, were never covered with trees, and, like the plains, were the homes of nomadic tribes —the Scythians—who wandered over the prairies as the American Indian. In climate, too, the steppes are similar to our own western regions, primarily fruitful in intense drouths and fearful storms.

Infinitely more inherently fertile than any region in Europe where forest culture has met with such success, the great American plains promise the most wonderful results in timber growth, and a few years will effect the most marvelous changes in their adaptability to the uses of man. The sandiest of deserts contain abundant supplies of water under their areas usually, even where no evidences of moisture are visible on their surfaces, and timber culture whenever extended in these regions has definitely determined the question of their possibilities in that direction favorably; how much more may we expect on the prairies of the Far West, whose whole surface is abundantly watered.

On the west coast of Africa the dunes of sand are quite moist a short distance below their exterior, and under the dunes of Algeria there is an abundance of water. On the Great Sahara the French find water at accessible depths. The several Pacific railroads have experienced no difficulty in establishing permanent wells along their lines wherever needed and at moderate depths, from which the water is raised by means of the most simply constructed windmills. Underneath nearly the entire area of the plains, at a distance of from ten to twelve feet, there is a stratum of soil containing sufficient moisture to sustain tree growth, and into this their rootlets strike and are nourished.

Viewing the results of the efforts made in Europe in the artificial creation of forests, it would appear that we need have no fears in this connection even for the dreaded Llano Estacado, which approaches nearer in its physical aspect to a desert than any other portion of our interior area, not excepting the Mauvaises Terres of Dakota and Montana.

General Pope thus describes the remarkable region of the Llano Estacado:*

* * "Proceeding westward, the most desolate portions of the United States, known as the Llano Estacado or *Staked Plain*—a treeless plateau elevated four thousand feet above the sea, a hundred miles or more in breadth, and stretching from the Canadian to beyond the northern confines of Mexico, unbroken by a single peak and underlaid by a nearly horizontal strata of red clay and gypsum. It is without wood or water. For thirty miles of the Pecos the surface is hard and covered with grama grass; and from thence to a point about thirty miles west of the Colorado of Texas, the hard surface alternates with patches of dark red sand, covered with bunch grass. The Llano Estacado presents no inducements to cultivation."

This is the gloomy view taken of that portion of our country twenty-five years ago, long before the idea was fully developed in Europe of redeeming sterile and desert lands by the introduction of timber. When we compare the Llano Estacado, with its carpet of grass, to the absolute deserts of Algeria and the

* Pacific R. R. Survey, 1852.

Great Sahara, and mark what the French government and Mehemet Ali have effected by the agency of man in reclaiming those reaches of drifty sands, we may predict equal possibilities for the Llano Estacado with its elements of fertility.

Over twenty millions of trees have been planted in the deserts of the Nile and their productive area extended wonderfully, and immense date groves, within the last twenty years, have sprung up at intervals on the Great Sahara, irrigated by artesian wells and surrounded by thrifty plantations.

General Emory, describing the Moro Valley, says: †"The plains were strewn with brick-dust, colored lava, scoria and slag; the hills to the left capped with white, granular quartz. The plains are almost destitute of vegetation; the hills bear a stunted growth of piñon and red cedar."

This valley is now one of the richest wheat-producing regions of New Mexico, and when the writer visited it ten years ago, its thriving villages and fine farms presented a curious contrast to the desolate picture drawn as above in 1846.

In the report of the Geological Surveys of the Territories,* Professor Cyrus Thomas in his investigations of the agricultural possibilities of the regions included in the surveys, says: "In calculating the probable development of the same, it is necessary to lay aside to a great extent all our ideas of agriculture based upon experience in the States. For, not only are the physical aspects of this portion of the West so different from the eastern half of our country as to strike the most superficial observer, but the climate is almost completely reversed, the thermometric and hygrometric conditions bearing no such relations to vegetation and agriculture here as there. Hence, the criteria by which we judge the fertility and productiveness of the soil and its adaptation to given products (except, perhaps, the strictly chemical tests) do not hold good here. The pale appearance of the soil, the barren look and stunted growth of a spot, are by no means conclusive evidences of its sterility, for the application of water may show it to be rich in vegetative force." Professor Thomas hints at the incorrectness of the earlier official reports on the subject of the Great Plains (as plainly asserted by myself), "that the primitive explorers condemned, in too hasty and general terms, the possibilities of that whole region to the uses of man, dwelling upon its desolateness and sterility in most emphatic terms."

Let us turn once more to some of the historic facts connected with the disboscation of a country and the alleged meteorological effects of thus disrobing a region of its timber.

M. Becquerel, of the French Institute, an unquestionable authority, says: "The effects of disboscation on the sources and quantities of living water which irrigate a country are of the most important consideration, and hence require serious attention. The difficulty in verifying these effects is the greater, inasmuch as it is impossible to say *a priori*, whether a forest or portion of a forest, destined to be cleared away, contributes to supply such or such a source, such or such a river. Springs are owing in general to the infiltration of rain-water in a previous formation, through which this water sinks until it meets with an impervious stra-

† Reconnoissances in New Mexico and California, 1846. * F. V. Hayden, U. S. Geologist, Report of 1870.

tum, flowing over the latter when it is in an inclined position, and eventually rising in streams or fountains; the water of wells has the same origin. Large springs are ordinarily found in mountainous regions. Forests also contribute to the formation of springs, not only by reason of the humidity which they produce and the obstacles which they oppose to the evaporation of the water which falls on the surface, but further because the roots of the trees, which, by dividing the soil render it more pervious, and thus facilitate infiltration."

Strabo informs us that it was necessary to take great precaution to prevent the country of Babylonia from being submerged. The Euphrates, which begins to swell, he tells us, at the close of spring, when the snow melts on the mountains of Armenia, overflows at the beginning of summer, and would necessarily form vast accumulations of water on the cultivated lands were not the superflux turned aside by means of trenches; this state of things exists no longer. M. Oppert, who, some years ago, traveled all through Babylonia, reports that the volume of water conveyed by the Euphrates is much less than in past ages, that inundations no longer occur, that the canals are dry, the marshes exhausted by the great heats of summer, and that the country has ceased to be insalubrious. This retreat of the water can only be attributed, as he found means to satisfy himself, to the clearing away of the forests on the mountains of Armenia.

DeSaussure† long ago pointed out the diminution of the water of the lakes of Switzerland—especially in lakes Morat, Neufchatel and Bienne, as a consequence of the clearing away of the forests.

Choiseul Gouffier was not able to distinguish in the Troad the river Scamander, which was still navigable in the time of Pliny. Its bed is now entirely dry; but the cedars also, which covered Mount Ida, whence it took its source, as well as the Simois, exist no longer * * *

M. Boussingault cites several examples leading to the same conclusions, but I will offer only two: "In 1826 the metalliferous mountains of Marmato presented only some miserable cabins inhabited by negro slaves. In 1830 this state of things no longer existed; there were numerous workshops and a population of three thousand inhabitants. It had been found necessary to level much wood; this denudation had proceeded but two years, and already a diminution was perceptible in the volume of water available for the labor of the machines." The other example cited by the same distinguished authority was furnished from the high table-lands of New Granada, elevated from six thousand to ten thousand feet above the sea level: "The inhabitants of the village of Dubatè, situated near two lakes, which were united sixty years ago, have witnessed the gradual subsidence of the waters, insomuch that lands which, thirty years ago, were under water are now subject to culture." M. Boussingault satisfied himself by a most rigid investigation that the diminution of the water in the lakes was caused by the extensive removal of forests in that vicinity. He found at the same time that Lake Tota, not far from Fuquene in that country, in a locality where the woods had not been disturbed, had suffered no loss in the volume of its water.

M. Desbassyres de Richemont states* that in the Island of Ascension a mag-

†Voyage dans les Alpes. *Cours d'Agriculture de M. deGasparin.

nificent water-source was desiccated in consequence of the destruction of the forest near by, which, however, flowed again and regained its full force upon the restoration of the timber.

From 1778 to 1835, in the Oder, and from 1828 to 1836, in the Elbe, the volume of water materially decreased so much so that Mr. Berghaus calculated that should it continue in the same ratio for a number of years it would force a "change in the construction of boats," but in this case it was not fully attributed to disboscation.

In the time of the Romans it is known they brought water from the fountain of Etureé to Orleans, but now that fountain is perfectly dry. An authority says: "Extensive excavations made within a few years have brought to light the foundations of Roman constructions where no source of water any longer exists; a stream, moreover, to the east of Orleans, which contributed to the defense of the city during the siege of 1428, and which was considerable enough to turn mills, has completely disappeared; now, on that side of Orleans there were great forests which have been cleared away. In consequence of these clearings, the wells of the city have continued to yield less and less water, so that the municipal administration has been obliged to incur an expense of three hundred thousand francs in order to bring potable water from the source of the Loire."

Bolando, in writing of the redwoods of California, says: "It is my firm conviction that if the redwoods are destroyed (and they necessarily will be, unless protected by the wise action of our government,) California will become a desert in the true sense of the word. In their safety depends the future welfare of the state; they are our safeguard. It remains to be seen whether we shall be benefited or not by the horrible experience which such countries as Asia Minor, Greece, Spain and France have made, by barbarously destroying their woods and forests. Wise governments would be able to replace them in those countries, but no power on earth can replace the woods of California when once completely destroyed."

*"Once a great pine forest bound with its roots the dune sand and the heath uninterruptedly from Danzig to Pillau. King Frederick William I. was in want of money. A certain Herr Von Koff promised to procure it for him without loan or taxes if he could be allowed to remove something quite useless. He thinned out the forests of Prussia, which then, indeed, possessed little pecuniary value; but he felled the entire woods of the 'Frische Nehrung,' so far as they lay in the Prussian territory. The financial operation was a success; the King had money, but in the elementary operation which resulted from it the state received irreparable injury. The sea winds rushed over the bared hills; the Frische Haff is half choked with sand; the channel between Elbing, the sea and Königsberg is endangered and the fisheries in the Haff injured. The operation of Herr Von Koff brought the King two hundred thousand thalers; the state would now willingly expend millions to restore the forest again"

This branch of the subject is so intensely interesting that it is with regret I

*"Man and Nature."[MARSH.

feel compelled to omit the mass of testimony I have collected from the most reliable sources, and which I deem necessary to a complete discussion of the question, for it is only by a rigid examination of authentic data that we are able to reach correct conclusions. To accomplish what I desired originally is impossible in the scope of a magazine, and we must be content with a mere skimming of the surface, which is all this article aspires to.

It is not within the province of this paper to enlarge upon the terrific destruction of timber in the forest regions of the United States, and the dire results that must inevitably follow if we can rely upon the light which history has thrown upon the subject of disboscation. But the lament will come from the next generation, as some writer has truthfully expressed it: "The people of this will only boast the swift change of the wood and the wilderness to the fertile field, and exult in the lines of towns and cities which spring up along its water-courses and overlook its lakes."

Three hundred years ago, Palissy, recognizing the indifference of present to future generations in this wanton destruction of forests, wrote: "When I consider the value of the least clump of trees, or even thorns, I much marvel at the great ignorance of men, who, as it seemeth, do nowaday study only to break down, fell and waste the fair forests which their forefathers did guard so closely. I would think no evil of them for cutting down the woods did they but replant again some part of them, but they care not for the time to come, neither reck they of the great damage they do to their children which shall come after them."

It requires no wondrous flight of the imagination to picture the physical condition of the United States in the next century, when the forests shall have been stripped from the granite hills of New England, from the Adirondacks, the Alleghanies, the far-reaching wooded borders of the Great Lakes, and the region east of the Mississippi. Then, if the people of the prairies west of the Missouri have been diligent in profiting by the examples of history, and have listened to the teachings of nature, let us imagine ourselves, with enlarged vision, standing upon one of the exalted peaks of the Snowy range, and describe the panorama spread out before us: Far beyond, like a gleam of sunshine, separating the continent into two widely diversified regions, flows the mighty Mississippi, the only river of its kind in the world. On its bosom is freighted to the ocean the products of the different latitudes through which it winds its majestic course. On either side are aggregated the vast manufacturing interests of the wonderful empire grown up in its fertile valley. The materials for the evolution, through the medium of mechanical genius into the forge and the loom, are transported to the vast continents of workshops by a magnificent network of railroads. In the old States, an impoverished soil induced by their denudation of timber, has reduced their once boasted productiveness to zero, while intense drouths, deluging storms and fitful variations of temperature mark the meteorological conditions of their whole area. That once fertile region has been rendered almost uninhabitable through the wantonness of man, and its former proud civilization transferred to the prairies beyond the Missouri. The "Great American Desert," depicted so graphically in the geographies of the last generation, has disappeared, and in its place is presented a system of agriculture such as the world scarcely ever dreamed of—marvelous in its results and grand in its diversity.

XUM

SCIENTIFIC MISCELLANY.

THE USES OF ARTIFICIAL STONE.

BY HENRY REED, C. E.

Building with concrete materials has been practiced in every age; but the Romans gave the greatest consideration to the subject and they constructed subaqueous works by that system thousands of years ago. Their name for a mixture of hydraulic mortar and broken stones was *signinum*, and with that preparation they constructed various piers and harbors on the shores of the Mediterranean Sea. Subsequently they added pozzuolana, which imparted increased setting energy to the comparatively inert lime, with the advantage of improved hydraulicity. French engineers in modern times adopted a similar system; but in England, from a variety of causes, the matter has not received that attention which its importance deserves.

A difference of opinion exists as to the difference between *beton* and concrete; and some writers endeavor to draw a distinction between the two, regarding *beton* as being made with hydraulic mortar and concrete prepared from non-hydraulic limes. Others again consider the difference to be in the mode of mixture; when the cement or lime is first mixed with sand, before being incorporated with gravel, it is termed *beton*, and when that preliminary operation is omitted it is called concrete. Such distinctions are too nice for practical purposes, and are alluded to only for the purpose of avoiding confusion in the use of the two terms. The names *beton* and concrete may therefore be considered synonomous, as indeed their names imply; and we may regard the term concrete as generic, embracing all mixtures of whatever description used for building purposes. English cob, Irish dab, and their several varieties, as well as Spanish *tapia* and Italian *pisa*, may be termed concrete, for they are respectively amalgamations of several materials.

General Pasley has assigned the merit of introducing concrete in England to Sir Robert Smirke, who used it on an extensive scale in the foundations of Millbank Penitentiary; and in his work on cements relates the accidental circumstances which led that eminent architect to the adoption of the preparation. It is immaterial to us who was the inventor or adapter of one kind or other of the different varieties of concrete, although we may be justified in ascribing it to an origin of great antiquity. The use of conglomorate masses of clay only, or in combination with other materials, continued through many ages of the world's history until the discovery of iron working, when man was enabled by its agency to adapt and shape stone to the required forms. Subsequent chemical knowledge led to the use of cementitious materials for connecting or binding stones; and clay, bitumen, sulphates and carbonates of limes, and pozzuolanas were severally used for

that purpose. Advancing engineering and chemical science, conjunctively experimenting on the varied properties of limes and cements, have succeeded in the introduction of a cement possessing the valuable qualities of moderately quick setting and permanent induration.

Vicat, Pasley and other practical investigators have ably assisted in this consumation by their painstaking and laborious researches on limes and artificial cements. Smeaton, however, in his experiments to ascertain the most suitable mortar with which to construct the Eddystone Lighthouse, initiated the method which eventually resulted in the discovery of Portland cement. Although lime in combination with pozzuolana or other volcanic products had been, from the time of Vitruvius, used to resist the injurious action of water, their beneficial conjunction was not satisfactorily explained until the time of the Eddystone experiments. Modern experience has somewhat modified Smeaton's conclusions, but, nevertheless, we may consider ourselves much indebted to him for a knowledge of hydraulic limes and the causes of their hydraulicity.

Architects, profiting by engineering experience, now look upon concrete with more favor, and begin also to appreciate its merits. Facility of executing the most detailed ornamentation in Portland cement, mortar or concrete, will ultimately secure its general adoption. In Germany great attention is bestowed on the preparation of a variety of articles in connection with building; and machinery of various kinds is used for molding and shaping architectural details which in this country are performed by the expensive agency of the plasterer or stone carver. Pipes for sanitary purposes are made by machine, and for many reasons are most suitable for the conveyance of sewerage. Many miles of sewers under the city of Paris have been constructed of *betons agglomeres*, a kind of concrete possessing many valuable peculiarities.

The several advantages secured in the construction of houses with concrete, and the facility with which the materials of almost every locality may be adapted for the purpose, is not the least important one. Improved means of resisting the climatic influences of our changeable atmosphere are commanded by the use of concrete walls, and numerous sanitary improvements are secured by its application. Its progressive hardening properties enable it to resist effectually the damaging influence of frost in the severest climates. Deleterious ingredients of the most vitiated atmosphere fail to disintregrate or otherwise damage it. The comparatively non-absorbent character of Portland cement and the improvement which it effects on any material with which it may be united, secure the maximum amount of comfort to the inmates of a house so constructed.

General Gilmore says: "Another interesting application of this material has been made in the construction, completed or very nearly so, of the light-house at Port Said, Egypt. It will be one hundred and eighty feet high, without joints, and resting upon a monolithic block of *beton*, containing nearly four hundred cubic yards. In design it is an exact copy of the Baleines light-house, executed after the plans and under the orders of M. Leonce-Regnaud, engineer-in-chief.

An entire Gothic church, with its foundations, walls and steeple, in a single

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piece, has been built of this material, at Vesinet, near Paris. The steeple is one hundred and thirty feet high, and shows no cracks or other evidences of weakness.

M. Pallu, the founder, certifies that "during the two years consumed by M. Coignet in the building of this church, the *beton agglomere*, in all its stages, was exposed to rain and frost; and that it has perfectly resisted all variations of temperature."

The entire floor of the church is paved with the same material in a variety of beautiful designs, and with an agreeable contrast of colors.

In constructing the municipal barracks of Notre Dame, Paris, the arched ceilings of the cellars were made of this *beton*, each arch being a single mass. The spans varied from twenty-two to twenty-five feet, the rise, in all cases, being one-tenth the span, and the thickness at the crown 8.66 inches. In the same building the arched ceilings of the three stories of galleries, one above the other, facing the interior, and all the subterranean drainage, comprising nearly six hundred yards of sewers, are also monoliths of *beton*.

One of these vault arches, having a span of 17½ feet, was subjected to severe three trial tests, viz:

First. A pyramid of stone work weighing thirty-six tons of two thousand pounds each, was placed on the center of the vault.

Second. A mass of sand thirteen feet thick was spread over the surface of the same vault.

Third. Carts loaded with heavy materials were driven over it.

In no instance was the slightest effect produced.

A portion of the basement work of the Paris Exposition building comprised a system of groined arches, supported by columns about 13¾ inches square and 10 feet apart. The arches have a uniform rise of one-tenth the span, and a thickness at the crown of 5½ inches, are monoliths of *beton agglomere*. A system of flat cylindrical arches of ten feet span, covers the ventilating passages. They have a rise of one-tenth, and a thickness at the crown of not quite 8 inches, and were tested with a distributed weight of 3,300 pounds to the superficial yard.

There was consumed in the construction of this basement work more than 353,000 cubic feet of *beton*.

Over thirty-one miles of the Paris sewers had been laid in this material prior to June, 1869, at a saving of 20 per cent. on their lowest estimated cost, in any other kind of masonry.

Several large city houses, some for places of residence, and others for business purposes, have been constructed, and many others are in contemplation. In these the entire masonry, comprising both the exterior and the partition walls, the chimneys with flues, cellar arches, cisterns, etc., is a single monolith of *beton agglomere*.

It may be advantageously used in fortifications, for foundations, generally, both in and out of water; for the piers, arches, and roof surfaces of casemates; for parade and breast-height walls; for counterscarp walls and galleries; for scarp

walls, except those that shield guns; for service and storage magazines; for pavements of magazines, casemates, galleries, etc., and generally for all masonry not exposed to the direct impact of an enemy's shot and shell."

OPTICAL EFFECTS OF INTENSE HEAT AND LIGHT.

BY JOSHUA THORNE, M. D.

The following facts have lately come under my observation at the rolling mills at this place:

While looking at the eclipse of the sun July 29th, I handed the glass to one of the mill "heaters." He at once told me he could see as well with the naked eye as with the smoked glass. I then tried another "heater," and he at once repeated the same statement. I then went to the rolling mill and tested every "heater" at his furnace. They all told the same story. I hunted up every "heater" in the town except two (who were not found), over twenty in all, and everyone declared he could see the phenomenon, and all its phases, as well or better with the eye unshaded. I took the precaution to test each one by himself, told him nothing of what I expected, or of the testimony of others. I made no suggestions to any of them, but let each tell his own story. All told the same tale; one peculiarity all agreed to, the image in the glass was upside down from what they saw with the naked eye. They would describe many peculiarities of color which could not be seen by others with the aid of the glass. It should be remembered that the "heater" has to see his iron in the furnace while it is enveloped in a flame whose intense glare prevents unskilled eyes from seeing anything, an education of the eye peculiar to this class of workers, as no other class of workmen is exposed to the same degree of heat or light.

I noticed as soon as the eclipse had progressed some time that I became nervous. I observed the same fact in many others about me. My wife at home did not think of the phenomenon at first, but became so nervous that she had to rush out of doors; she then saw the eclipse for the first time. I found this nervousness more in women than among men, chiefly in persons of debilitated frame, such as convalescents. Is this magnetic?

In accordance with your request, I repeated the experiment of Ericsson, and submitted a spherical piece of iron, eight inches in diameter, to a heat of over 3,000 degrees, Fahr. It was carried to an almost melting point, withdrawn from the flame and placed on a stand. It had the appearance of a disc at all distances tried, up to over 100 feet. As seen by Mr. Hughes, the chief engineer of the mill (one of the most scientific men in his line in the West), myself and others, it was perfectly *flat*. The convexity did not appear; it was while in this state, to all appearance no longer a *sphere*, but a *disc*. As the iron cooled off it resumed its original appearance of a sphere. Our mill men were much surprised by this phenomenon which they had been seeing all their lives, but till now had never observed.

ROSEDALE, Aug. 12, 1878.

XUM

DENSITY OF POPULATION AND HEALTH.

At a general conference of British architects, a few weeks ago, the general building regulations of the United Kingdom were discussed at length. Among the points brought out were these: 1. That the experience of what are called model lodging houses, such as the Peabody buildings in London and other large towns, combined with that of barracks, workhouses, and schools, furnishes abundant evidence that what is termed density of population is not so detrimental physically as has been hastily assumed; because in such buildings as are referred to the rate of mortality is much less, with a density of 1,500 persons to the acre, than it is in ordinary small houses, with a density of only 250 to the acre. 2. That the health of a community is much more dependent upon food, clothing and personal habits than upon the arrangement and construction of dwellings or workshops; for however perfect may be the arrangement and construction, they may be entirely neutralized if the food is bad, the clothing deficient, and the personal habits filthy.

The unsanitary conditions of densely populated districts in this city seems to be chiefly due to the fact that the houses of the inhabitants were not originally intended for those who have come to live in them.—*Scientific American.*

BOOK NOTICES.

A COURSE IN ARITHMETIC. A treatise in three parts, complete in one volume. By F. W. Bardwell, Professor of Astronomy in the University of Kansas. 12 mo.; pp. 154. G. P. Putnam's Sons, New York. For sale by M. H. Dickinson, $1.25.

The necessity for a new treatise on Arithmetic, and the advantages of this treatise over some others, are pointed out by Professor Bardwell so modestly, and at the same time so clearly, that we cannot do better than quote his own language: "First, it is intended to present, in the compass of a single volume, a complete treatise, and, indeed, all that the average pupil needs to study on the subject from first to last. Secondly, the subject matter is arranged in three parts, logically distinct, in each of which the pupil gives his attention to a specific object complete in itself. The first part comprises the simple operations; the second, an explanation of the various measures in use, including the metric system; the third, the various applications of numerical computation to practical questions. A third marked feature is found in the character of the definitions and of the expositions of principles. The treatment of each topic is lucid and logical, and, at the same time, in harmony with rigorous scientific accuracy." One point, in which we especially agree with the author, with whom "the conviction has been reached only with deliberation and after long experience and observation," is that much time has been wasted in so-called Arithmetical drill, i. e., in "mental" or "intellectual" exercises. A practical improvement that we notice as peculiar to Professor Bardwell, is giving the definitions and rules in the

shape of a "Review" after each chapter of demonstrations and principles. This, to our notion, is the natural and proper order and one which is just the reverse of the method of the arithmeticians of our school-days.

This Course is unusually full, extending from numeration to mensuration, and closing with tables of Insurance, compound interest, miscellaneous estimates, etc. The work is comprehensive, practical and of logical arrangement and will doubtless become popular wherever introduced.

ANNUAL RECORD OF SCIENCE AND INDUSTRY FOR 1877. Edited by Spencer F. Baird, with the assistance of eminent men of science. New York, Harper & Brothers, 1878. For sale by M. H. Dickinson, successor to Matt. Foster & Co., $2.00

This familiar visitor, the seventh of the present series and the twenty-seventh of a series commenced in 1850 and known as the Annual of Scientific Discovery, made its appearance upon our table several weeks since; too late, however, for notice in the July REVIEW. Professor Baird has somewhat changed the plan of the work as heretofore published, by summarizing the work done by societies and individuals instead of giving abstracts of important papers, reports, &c. This has been rendered absolutely necessary to avoid extending the size of the volume beyond bounds; otherwise, it would to us seem an objectionable change.

The subject of Astronomy has been worked up and arranged by Professor Holden, of the United States Naval Observatory; that of Physics of the Globe, by Professor Cleveland Abbe, of the Weather Bureau; those of Physics and Chemistry, by Professor George F. Barker, of the University of Pennsylvania; that of Mineralogy, by Professor Edward S. Dana, of Yale College; that of Geology, by Professor T. Sterry Hunt, of the Institute of Technology, Boston; those of Geography and Hydrogaphy, by Lieutenant-Commander F. M. Green, U. S. N.; that of the Geography of North America, by Professor S. H. Scudder, of Cambridge, Massachusetts; Microscopy, by Professor Hamilton L. Smith, Hobart College; Anthropology, by Professor Otis T. Mason, Columbian University; Zoölogy, by Professor A. S. Packard, Jr., Peabody Academy of Science; Botany, by Professor W. G. Farlow, Harvard College; Agriculture and Rural Economy, by Professor W. O. Atwater, Wesleyan University; Engineering, Technology and Industrial Statistics, by Professor W. H. Wahl, Philadelphia, Pennsylvania; Bibliography, by Professor Theo. Gill, of the Smithsonian Institute. All of these gentlemen stand at the head of their respective departments and their work can be relied upon as accurate, comprehensive and brought down to the most recent dates. In many respects this volume is superior to any of its predecessors, and the series has no equal in the scientific world for completeness, whether in design or execution.

MANUAL OF THE VERTEBRATES OF THE NORTHERN UNITED STATES.—By David Starr Jordan, Ph. D., M. D., Professor of Natural History in Butler Uni-

versity. Chicago, Jansen, McClurg & Co., 1878, large 12 mo., pp. 407. Sold by H. H. Shepard. Price, $2.50.

We spoke of this valuable work somewhat extendedly a few months since in the REVIEW, but having since then received a complete copy from the publishers, we have examined it thoroughly and find it all that the advance sheets, sent us at that time, promised.

The Manual of 1876 has been thoroughly revised and much of it re-written, especially that portion pertaining to the fishes, including descriptions of all the American salmon and trout, with their habits and technical names, which feature ought to commend the book to sportsmen as well as scientists. In every class, order and family the descriptions are brief but clear, while all of the lately discovered species are taken account of in their proper places. Such works are of the greatest value to the general reader, and frequently to editors as books of ready reference. We have placed this volume in our hand rack along with Orton's Comparative Zoology, Buckley's History of Natural Science, Rodwell's Dictionary of Science, Wagner's Technology, the Annual Record of Science and Industry, etc.

HOW SHE CAME INTO HER KINGDOM. A ROMANCE.—By Mrs. Charlotte M. Clark. Jansen, McClurg & Co., 1878, 12 mo., pp. 337. For sale by H. H. Shepard. Price $1.50.

It is difficult to give an idea of this remarkable book in the few lines we can spare to it. Suffice it to say, that Mrs. Clark has a vivid imagination and excellent descriptive powers, which, with her manifestly excellent education and training in physical matters, will, when properly toned down, make her one of the most popular writers of the day.

The plot of the book is decidedly original and combines many bold and startling scenes and effects, which culminate in the coming of the heroine "into her kingdom" through great tribulation and many trials. It is richly worth perusal and no one who commences it will lay it down unread.

THE PRIMER OF POLITICAL ECONOMY.—By Alfred B. Mason and John J. Lalor. Chicago, Jansen, McClurg & Co., pp. 67. For sale by H. H. Shepard. Price 75 cts.

This is an attempt by the authors to give the principles of Political Economy in sixteen definitions and forty propositions, and it is so far successful that many of our latter-day statesmen would be largely benefited by a careful study of them. It is intended, the authors say, for use as a text book in the schools, and as such, doubtless, will be of great service, being the result of much study and research on the part of the authors, and written in a simple and attractive style.

CATALOGUE OF THE MISSOURI UNIVERSITY AT COLUMBIA, MO., 1877–1878.—Jefferson City, Regan & Carter, octavo, pp. 136.

The University of Missouri was founded by a grant of some 40,000 acres of land to the state for that purpose in 1820, but was not located until 1839, when

the commissioners appointed for the purpose unanimously selected Columbia as the site. In 1862 a munificent land grant for agricultural colleges was made by Act of Congress, which largely increased the endowment of the University, so that it is now freed from all pecuniary embarassments.

The different departments of the University are the Academic schools, at which the sciences and languages are taught, and the Professional schools, at which Agriculture, pedagogics, law, medicine, mining and metallurgy, engineering and art are taught by capable and distinguished professors, aided by the most modern instruments and other appliances. Very few persons have an idea of the extent and importance of our State University, and it would, doubtless, surprise and gratify a large majority of our citizens to examine this catalogue.

EDITORIAL NOTES.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE opens its twenty-seventh annual meeting at St. Louis, on the 21st inst., with rendezvous at the Lindell Hotel, after which the general sessions will be held at Armory Hall.

The officers of the Association are as follows:

President, Prof. O. C. Marsh, of New Haven; General Secretary, Prof. H. Carrington Bolton, of Hartford; Permanent Secretary, Prof. F. W. Putnam, of Cambridge; Vice President section A., Prof. R. H. Thurston: Vice President section B., Prof. A. R. Grote; Secretary section A., Prof. F. E. Nipher, St. Louis, Mo.; Secretary section B., Prof. Geo. Little, Atlanta; Treasurer, W. S. Vaux, Philadelphia, Pa.; Chairman of Permanent Subsection of Microscopy, Prof. Geo. S. Blackie, Nashville; Chairman of Permanent Subsection of Chemistry, Prof. F. W. Clarke, of the University of Cincinnati, Ohio.

The indications are that this meeting will be very largely attended by the most prominent scientists of this country and Europe, and the people of St. Louis are making special preparations to entertain them.

A special invitation has been extended to the foreign scientists, Norman Lockyer and Prof. Janssen to attend the meeting, and the invitation will undoubtedly be honored. Thos. Bell, F. G. S., of London, England, is also coming. Prof. Simon Newcomb, of the the Naval Observatory, Washington, Dr. Asaph Hall, the discoverer of the satellites of Mars, Prof. J. A. Rogers, Prof. Wm. Harkness, Alvan Clark, the greatest manufacturer of astronomical lenses of any age, Prof. J. R. Eastman, H. S. Pritchett, of Glasgow, Mo., Prof. E. S. Holden, Dr. C. S. Hastings, L. Trouvellot, G. W. Hill, of the Nautical Almanac, Ormond Stone, of Cincinnati, Gen. Meyer and Prof. Abbe, of the Signal Service, Prof. Langley, of Alleghany Observatory, G. F. Baker, of Philadelphia, Dr. Bolton, of Hartford, Conn., General Secretary of the Association, Prof. F. W. Putnam, of Cambridge, Mass., its Permanent Secretary, Dr. Goodale, of Harvard, Prof. Ricketts, of Columbia College, Thomas Mehan, of Germantown, Pa., H. C. Lewis, Thos. Bassnett, of Florida, P. W. and W. S. Sheafer, of Pottsville, Pa., Oliver M. Bryant, of Accokeek, Md., J. H. Kellogg, of Battle Creek, Mich., R. W. Thurston, of Hoboken, A. P. S. Stuart, of Lincoln, Neb., S. A. Latimer, of Rochester (N. Y.) University: President O. C. Marsh, of New Haven, Benjamin Pierce, of Cambridge, Jas. D. Dana, of New Haven, Jas. Hall, of Albany, Isaac Lee, of Philadelphia, T. A. P. Barnard, President of "Columbia," Stephen Alexander, B. A. Gould, Thomas Sterry Hunt, all of Boston, Prof. Asa

Gray, of Cambridge, J. L. Smith, of Louisville, J. S. Lovering, of Cambridge, John L. Leconte, of Philadelphia, Prof. J. E. Hilgard and W. H. Dall, of the Coast Survey, S. A. Goldschmidt, the eminent young chemist from New York, and Prof. C. A. Young, besides a number of ladies of scientific attainments. Prof. J. K. Rees, of Washington University, St. Louis, is the local Secretary, to whom all inquiries should be addressed.

As long ago as 1855, Professor G. C. Swallow, then State Geologist of Missouri, declared in his official reports and otherwise, that this portion of the state, and also Eastern Kansas and Southeastern Nebraska, were all underlaid with coal. He also pointed out the existence of the immense deposits of lead and zinc which have since been discovered in Southwest Missouri and Southeast Kansas. The long-worked vein of coal at Leavenworth and the newly-discovered one at Rosedale, now also testify to the correctness of Professor Swallow's statements and the remarkable accuracy of his geological knowledge.

THE following items in regard to the eclipses of the sun and moon as observed at this city are furnished by Mr. W. W. Alexander, Optician, No. 9 East 7th street:

The observed time of the Solar eclipse of July 29, 1878, was as follows, Kansas City mean solar time: First contact, 3 hours 12 minutes 34 seconds, p. m.; last contact, 5 hours 18 minutes 13 seconds; duration from first to last contact, 2 hours 5 minutes 39 seconds; magnitude about 10 digits, or $\frac{5}{6}$ of sun's diameter.

The Lunar eclipse of August 12, 1878, last contact (alone observed here) with earth's umbra, or darkest shadow, 7 hours 17 minutes 23 seconds. p. m., Kansas City mean solar time. Duration from moon rise about 27 minutes.

OF the September monthlies only *Harper's* and the *Atlantic* have as yet made their appearance. Both are excellent numbers, containing essays, stories and poems at least up to the usual high standard of these magazines.

THE RAIN-FALL at Kansas City, for the past twelve months, as recorded and reported to the Signal Officer at Washington was as follows:

August, 1877,	rain fell	2	days to amt. of	1.54	ins.
September, 1877,	" "	6	" " "	3.66	"
October, 1877,	" "	9	" " "	6.96	"
November, 1877,	" "	8	" " "	2.50	"
December, 1877,	" "	13	" " "	2.60	"
January, 1878,	" "	10	" " "	1.27	"
February, 1878,	" "	8	" " "	1.96	"
March, 1878,	" "	14	" " "	3.45	"
April, 1878,	" "	10	" " "	2.70	"
May, 1878,	" "	15	" " "	4.51	"
June, 1878,	" "	16	" " "	2.62	"
July, 1878,	" "	10	" " "	2.20	"
Twelve months,	"	121	" " "	35.97	"

There were but four snow storms during the winter in which snow fell enough to be measured, the total fall for the season being just seven inches.

THE following items are taken from the daily bulletin of the Signal Office:

LOCALITY.	Highest.	Lowest.	Mean.
San Francisco, Cal.	71°	60°	64.3°
Sacramento, "	94	81	88.5
Denver, Col.	97	72	85
Kansas City, Mo.	95	75	87
St. Louis, "	96	76	87

Observations taken at about 3:30 p. m. each day for ten days, from August 3 to 12, inclusive.

The greatest change of temperature in twenty-four hours occurred at Dodge City, Kansas, and Denver, Colorado: at the former the thermometer indicated twenty-seven degrees less at 3:30 p. m. on the 10th than on the previous day at the same hour, and at Denver twenty-three degrees less on the 9th.

PARTICULAR attention is called to the advertisements of Marietta College, Ohio, and the Colorado State School of Mines at Golden, Colorado. Both are first-class institutions in their respective lines and both deserve the patronage of Western people. We have the honor of a personal acquaintance with most of the Professors in both of these schools and know that they are most faithful, competent and experienced teachers; men who have devoted their lives to the profession and whose highest ambition is to send forth from their respective colleges young men who will be a credit to them and a benefit to the country.

We are indebted to Dr. A. H. Thompson, of Topeka, Kansas, for a photographic representation of some very interesting pieces of pottery (Navajo, Pueblo?) belonging to his collection. They resemble quite closely some specimens shown us last spring at Charleston, Mo., with the exception of one, which is more artistically and profusely ornamented than any we have ever seen.

A TERRIFIC rain storm visited Larned, Kansas on the night of the 19th July, which in volume is without precedent in all the recorded meteorological measurements. Dr. O'Brien, Surgeon at the Fort, informs us that the actual number of inches in ten hours—the period of the storm—by the gauge, marked six. We have diligently searched the registry of meteorological phenomena in our possession—extending back for thirty-five years—and find as stated above, the amount of rain in inches that fell in the recent storm without precedent west of the Missouri. In 1843-4-5-6, the years of greatest rain-fall, eight, twelve and fifteen inches are the greatest for any *one month*. In 1869, thirteen inches fell in twenty-four hours, but when we consider that in only ten hours, *six* inches fell—which in round numbers is equivalent to forty thousand tons of water, or nearly one hundred and thirty thousand hogsheads to each square mile—some idea may be formed of the vast volume that was precipitated in this region, and places the storm almost in the category of cloud bursts.—*Chronoscope*.

THE Geological features of the Leadville region are said to manifest some striking peculiarities. Leadville itself—which is situated well up toward the head of the gulch—has an altitude of 10,200 feet, and is, consequently, very near timber-line. The mountains and gulches in the immediate vicinity are rounded and worn down by erosion, and nearly all of the rocks are of volcanic origin. In places the strata are horizontal, then inclined at an angle of 45°, and again tumbled and broken up in all manner of shapes, as though some powerful agent had forced its way through the bowels of the earth. The top rock is of a porphyritic nature, and overlies limestone of the Jurassic period. The junction of the two rocks is termed the "contact," and here the carbonic mineral is usually found.

A BEAUTIFUL meteoric display was witnessed at Titusville, Pa., August 11. A meteor made its appearance in the West at 10:20 p. m., moving in a northerly direction. It was of a greenish color and shone with great brilliancy, lighting up the heavens with a light that, for a time, prevailed over that of the full moon. Its appearance was only momentary, when it burst, dividing itself into three fragments, two of which assumed a reddish color. Calculating from the time it was seen until it was heard, the meteor was about twenty-five miles distant.

JAMES G. YOUNG,

ATTORNEY AT LAW,

Rooms 10 and 12, Hart's Office Building, West 4th St., bet. Main and Delaware,

KANSAS CITY, MO.

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